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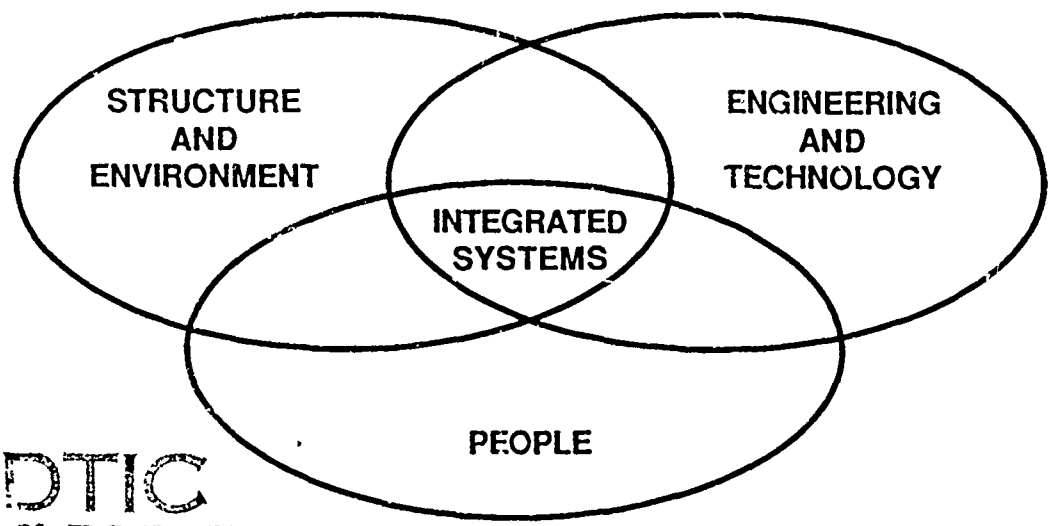

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The MANPRINT Primer is designed for both Army and industry MANPRINT practitioners. It provides a basis for their activities and specific "how to" guidance to deal with MANPRINT activities that must occur throughout the materiel acquisition life cycle.

Chapter 1 is an introduction to MANPRINT; it provides the Army's conceptual basis and thrus in MANPRINT. Primary roles and responsibilities for Army and industry are shown in Chapter 2 and Appendix F. Chapter 3 focuses on various aspects of program management--organization planning, scheduling, and resourcing of a comprehensive MANPRINT program throughout the design and development cycle. Technical MANPRINT management is addressed in Chapter 4 in discussions of force level analyses; issues in each of the MANPRINT domains; and planning f and selecting analytical techniques and methodologies for use in satisfying information needed. Chapter 5 is a discussion of future directions.

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PREFACE

This MANPRINT primer is designed for both Army and industry MANPRINT practitioners. It provides a basis for their activities and specific "how to" guidance to deal with MANPRINT activities that must occur throughout the materiel acquisition life cycle.

Chapter 1 is an introduction to MANPRINT. It provides the Army's conceptual basis and thrust in MANPRINT. Primary roles and responsibilities for Army and industry are shown in Chapter 2 and Appendix F. Chapter 3 focuses on various aspects of program management--organization planning, scheduling, and resourcing of a comprehensive MANPRINT program throughout the design and development cycle. Technical MANPRINT management is addressed in Chapter 4 in discussions of force level analyses; issues in each of the MANPRINT domains; and planning for and selecting analytical techniques and methodologies for use in satisfying information needed. Chapter 5 is a discussion of future directions.

MANPRINT is an evolving program. Comments and recommendations regarding the MANPRINT program or this primer are welcome. Please complete the reader response form at the end of this document and return it to: HQ, Department of the Army, Attn: DAPE-MR, Washington, D.C. 20310-0030.

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CHAPTER 1
INTRODUCTION TO MANPRINT

1.1 GENERAL DEFINITIONS

The Manpower and Personnel Integration program (MANPRINT) is a comprehensive management and technical program to enhance human performance and reliability in the operation, maintenance and use of weapon systems and equipment (hereafter referred to as "system"). MANPRINT achieves this objective by focusing attention on human resource goals and constraints during system design, development, production and upgrade. See # p.4

Human resource goals and constraints are addressed in MANPRINT through six domains: manpower, personnel, training, human factors, system safety, and health hazards. The first four domains directly influence human performance and human reliability. The impact of system safety and health hazards is more indirect but can also degrade total system performance if they are overlooked during system development.

MANPRINT is a multifaceted program. Individuals and organizations concerned with training, testing and evaluating, logistics, and materiel development have their own perspectives on MANPRINT. However, all benefit from MANPRINT. MANPRINT improves coordination between users and developers of new systems. Furthermore, it can enhance or complement the role each individual and organization plays in Army acquisition programs. Consequently, Army combat developers, trainers, acquisition specialists, testers and evaluators, logisticians, laboratory scientists, and engineers, et al. are involved in MANPRINT.

MANPRINT success depends on the combined efforts of these specialists in the Army and industry. Although each has its own responsibilities, their interests mesh in the communication on MANPRINT requirements and the development of design solutions to. The Army must establish and maintain a close and continuous relationship with industry, informing industry of both its requirements and its assessment of industry's responses to their requirements, as well as working with industry on a day-to-day basis in a joint effort to assure that MANPRINT is meaningfully included on system design influence. Industry must design and fabricate a system that enhances human performance and human reliability and thereby improves total system performance.

1.2 THE SYSTEMS INTEGRATION CHALLENGE

The systems integration challenge facing the Army can be seen from two perspectives:

- From a congressional perspective, the fundamental question put to the Department of Defense (DOD) is "Are the Armed Forces getting what they are paying for in total weapon system performance or are

critical resources being wasted to acquire high-capability technology that exceeds the limits of human capability?"

- From the Army perspective, the problem focuses on generating, and sustaining combat power to meet the threat. The issue is how to integrate technology, people, and force structure to satisfy mission objectives under all environmental conditions at the lowest possible life cycle cost.

Increasingly, the Army has found it necessary to rely on engineering and technology to obtain quantum jumps in capability to meet near-term and projected long-term threats. It looks toward technology to replace people whenever possible in the interest of achieving the optimal distribution of manpower. But new system technology is not a solution in itself. If system design is not governed by pre-established MANPRINT goals and constraints, the Army will be plagued by mismatches among the equipment, the soldier operators and maintainers, the civilian maintainers at depot level, and the Army force structure. The central objective of MANPRINT, then, is to influence system design in an effort to optimize total system performance by enhancing human performance.

To understand the relationship between force structure, soldiers, and technology, it is useful to examine a hypothetical situation. Increases in the number of Warsaw Pact combat forces require an increase in our combat power to destroy these forces. The Army increases combat power by increasing the force structure and/or by developing advanced technological equipment. This is not the simple tradeoff it seems. Increases in force structure require a redistribution of the Army's finite people resources. Manpower may be pulled from combat support or combat service support, but that may decrease the ability to sustain the force and adversely affect readiness.

Advanced equipment may not, in itself, reduce the manpower requirements, because the advanced technology and complexity may require soldiers with higher aptitude and skill levels, particularly for maintenance and repair. If personnel lack the requisite aptitudes and skills, then the Army's options to meet the threat are to increase force structure, manning levels, or training time. But the manpower ceiling and the demand for more combat power preclude increasing force structure or manning levels. The Army might increase soldier training to acquire the needed aptitudes and skills, but increased training time may require more instructors, and removes personnel from the field. This requires more personnel to replace those being trained in order to maintain the same level of readiness. The Army has concluded that, given a declining end strength, advanced systems must be designed for the typical soldier and projected force structure.

MANPRINT seeks to reduce both the demand for skilled manpower and the operating and support costs associated with the acquisition of new materiel. By dealing with these issues up front, it assures that total Army force structure and soldier capabilities are reflected in the decisions that affect each individual weapon system development.

1.3 ASSESSING THE RETURN ON INVESTMENT

The Army is faced with a basic return on investment (ROI) decision in determining if a new weapons system will yield the total systems performance the Army is paying for. Traditionally, Army acquisition decisions have been constrained primarily by equipment research and development (R&D) and investment/procurement costs. Therefore, the decision may be to go with a high-capability technology that exceeds the bounds of general soldier ability because the initial up-front costs may be lower. The ROI frequently is not properly estimated because the life-cycle costs of manning, training, and supporting the total system are not completely assessed in the initial decision. Figure 1-1 illustrates the correlation between soldier ability requirements and R&D and investment costs versus life-cycle costs. The total system life-cycle costs must be an integral part of assessing the ROI.

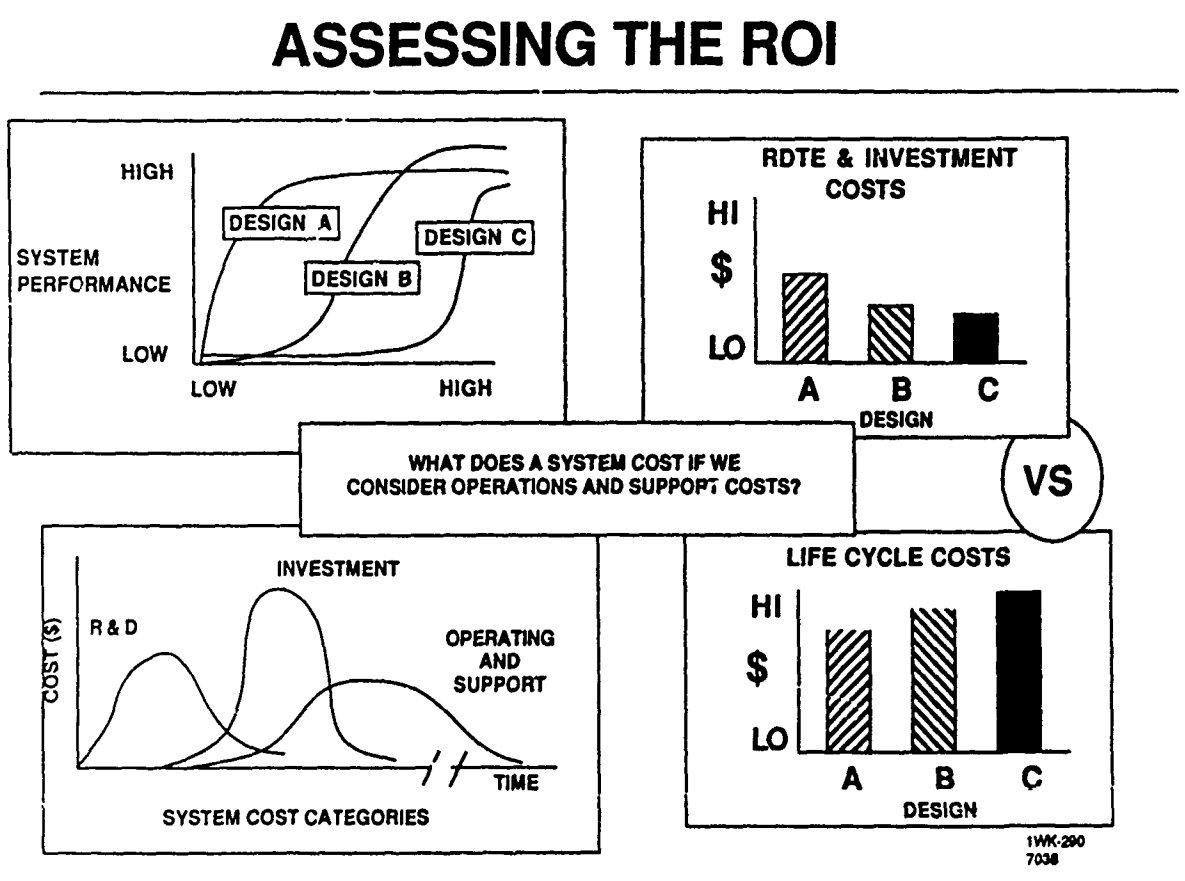

Figure 1-1. Assessing the ROI

1.4 THE TOTAL SYSTEM PERSPECTIVE

The total system includes all of the people, equipment, doctrine, training, etc., necessary to field and sustain the system in peace time and combat. The total system includes not only the principal item, but also the associated support items of equipment, the other support equipment, and training devices. Each has its own respective logistical tails necessary for sustainment.

Historically, Army requirements documents, the foundation of future system design, have not quantified total system performance; constrained the total manpower numbers; limited the personnel skills anticipated for a given level of performance; or constrained training time. This approach has resulted in a "manning the equipment" concept, where the soldier is an afterthought, a support item to be married to the equipment after the essential design direction has been determined. Despite the supposed reliance on high technology and/or equipment complexity to achieve system performance, all too often design capability and readiness goals are not achieved. Soldiers frequently cannot properly operate, support and maintain the equipment. Thus, it should not be surprising that in a report to Congress, the General Accounting Office, using information provided by the Services, attributed half the failures of all military weapons and support systems to human error.[1]

Force structure and environmental parameters must be provided by the Army to ensure that new systems are designed to integrate easily into that structure and environment. Generally, if a new system adds a new or significantly increased manpower requirement to the force structure, the Army must man the new structure by degrading (qualitatively or quantitatively) an existing organization. The impact can be far reaching, affecting the mix of commissioned specialties and enlisted military occupational specialties grade structure and authorized level of organization (ALO). Important Army force structure units will remain unmanned because of the Army's current manpower cap.

An Army unit designer has to consider the threat capability, risk, mission, doctrine, force structure, and available resources in designing a unit. The unit must be designed so that various levels of resources can be added or deleted to give the unit specific capabilities to meet varying, sometimes unpredictable threats. So the challenge is to design and build units in peacetime which can be mobilized and expanded to meet a wartime threat. Figure 1-2 illustrates this process using the basic system model.

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1 Comptroller General of the United States. Effectiveness of the U.S. Forces can be improved through Improved Weapon design. Washington, D.C.: General Accounting Office, PSAD-81-17, January, 1981.

UNIT DESIGN

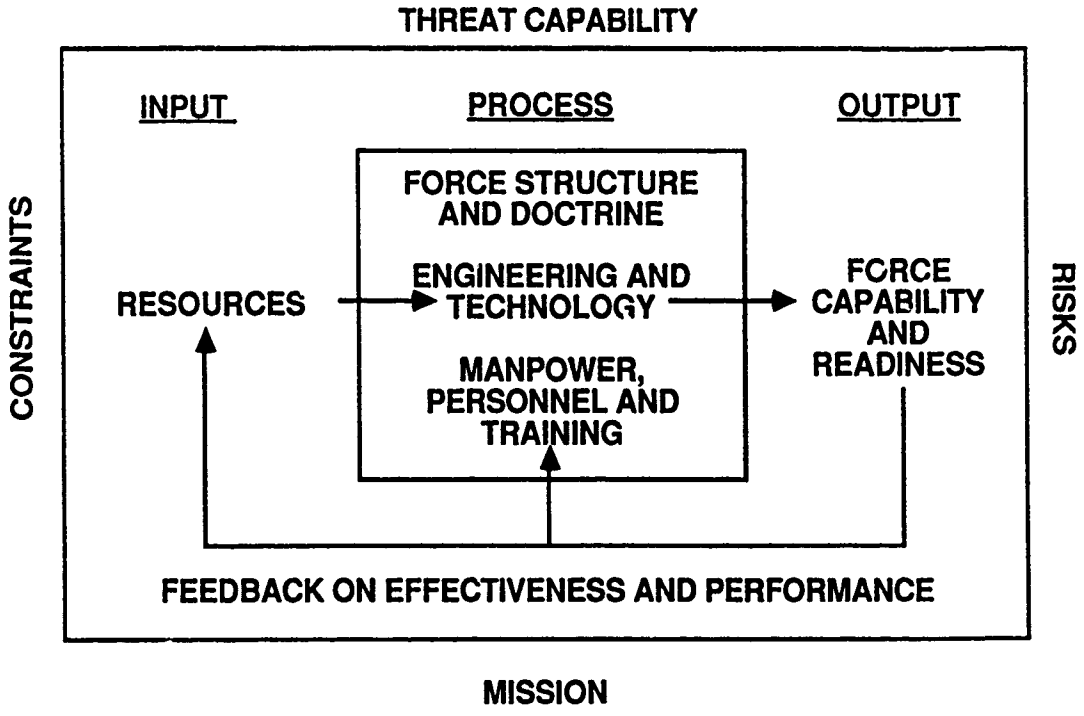

Figure 1-2. Unit Designs

The Army continues to face significant soldier/machine interface problems, many of which are the result of unbalanced attention to hardware capability at the expense of total system and human performance. In the past, increased capability achieved with advanced technology, has often been accompanied by increases in soldier task complexity. System design was not impacted by MANPRINT design constraints or by a disciplined process that insisted on putting "the man-in-the loop." Instead, the system design process was built on the unstated premise that sufficient numbers of skilled soldiers would always be available to operate, support, and maintain the system.

1.5 THE FUNDAMENTAL GOALS OF MANPRINT

The goals of MANPRINT are to improve:

- o Total system performance, by including human performance as an integral element. Total system performance is a function of equipment performance and people performance as they ach are affected under varying environmental conditions, which include physical, social, and operational conditions.

- o Manpower and personnel utilization. All too often personnel requirements are dictated by materiel system design.

- o Unit effectiveness by affecting the first two goals. This will enhance the ability of units to perform their mission.

To effectively accomplish these goals, the MANPRINT issues must be addressed early and continuously throughout the materiel acquisition process.

1.5.1 Human Performance and Reliability

Although human performance and reliability might be considered to be overlapping terms it is useful to consider them separately. Human performance is the degree to which an individual is able to accomplish a task, or series of tasks under specified conditions, to meet a specified standard. Examples of key human performance areas include such things as how well a soldier can sight a weapon, troubleshoot a malfunction, or input requests for spare parts on a computer. Individual variability in these performances is an important consideration in system design.

Human reliability refers to the probability that a human will make an error in the operation, maintenance or support of a system. Equipment reliability, measured by mean time between failure (MTBF) and mean time to first failure (MTFF), affects system results. Human reliability, measured by mean time between human error (MTHE) and mean time to first human error (MTFH) also affects system results. Thus the study of human reliability separately from performance will provide important estimates of the probability of mission success.

1.5.2 The Design Challenge

The human contribution to a system must be designed into system effectiveness, system reliability, system durability, and cost-effectiveness. Throughout the design process it is important to identify each anticipated source of variation in expected system performance. Then, if it develops that the soldier is contributing to a large component of variation on predicted system performance, MANPRINT seeks to lessen the

impact by improving the system design rather than extending training time or assigning more or higher aptitude soldiers. MANPRINT will seek out potential variations before programs are initiated and establish goals and constraints. It is imperative that human performance and reliability impediments be eliminated early, beginning with system concept design. Thus, it is through careful system design that the Army will reduce its need to tax the limited pool of higher aptitude personnel.

The Army is implementing MANPRINT as a tailored program for all materiel acquisitions, ranging from major weapons systems to less costly product improvements (PI) and non-developmental item (NDI) acquisitions. The Army has put in place an intensive front-end analysis effort to identify realistic MANPRINT goals and constraints, ultimately appearing as contract design requirements. As an acquisition proceeds the contractor will be required to employ various predictive and tradeoff design techniques to demonstrate conclusively that design options have accounted for the MANPRINT requirements. The Army will not accept the breaching of MANPRINT goals and constraints without completely understanding the ramifications early in development and without having assurance that the Army can accommodate the changes. Army decision makers will expect clear and convincing evidence from the contractual effort and from Army tests and evaluations to demonstrate that human performance and reliability requirements have been achieved and have made their proper contribution to total system performance.

For example, human performance capabilities and reliability must be considered in the comparison of alternative and competing designs. They must become important factors in the Army decision process. Human performance and human reliability should not be viewed as a specific point value but rather as a range of human performance. It is a function of the ability of soldiers, realizing that abilities are influenced by the variables that affect human beings. First, all design decisions are influenced by cost considerations. The basic issue is reflected in Figure 1-3. Should the Army select Design A, which is highest in cost but which is operable and maintainable by lower aptitude (quality) soldiers or should it select Design C, the lowest cost system with the highest aptitude demands? On the other hand, should the Army compromise on Design B as a balance between aptitude demand and cost?

SELECTION OF ALTERNATIVES

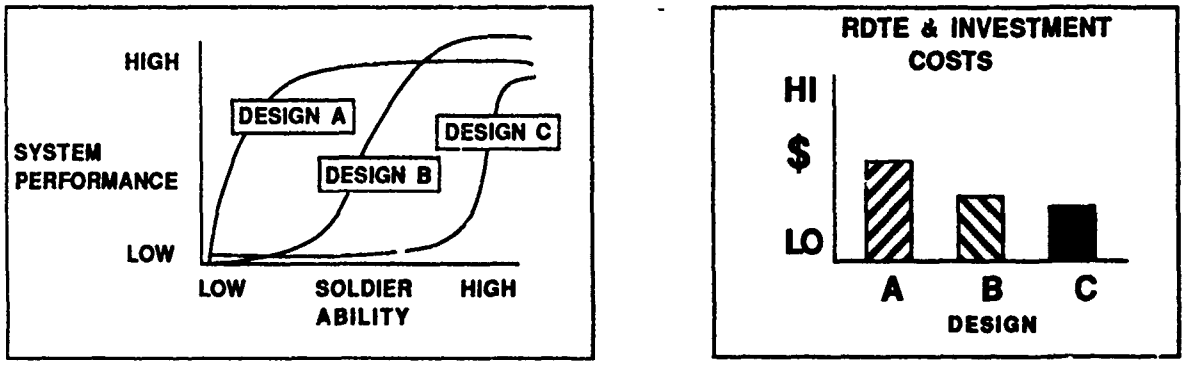

Figure 1-3. Selection of Alternatives

The decision is of course, system specific depending on the judgment of the decision makers as to the balance that best serves the Army's needs. The final decision revolves about the question of tradeoffs and options in terms of system performance and resources, manning and skill distribution.

1.6 THE OBJECTIVES OF THE MANPRINT PROGRAM

The goal of MANPRINT is to optimize total system performance. It will bring options and a better understanding of the impact of hardware/software designs on human performance and reliability. Army decision makers will be looking at the numerous variables and alternatives involved in choosing an optimized system design. The disciplined approach to achieve the MANPRINT goal is reflected in these formal Army objectives:

- Influence materiel system design for optimum total system performance by considering human factors engineering, manpower, personnel, training, system safety, and health hazards before allocating functions between people, hardware, and software.
- Assure that Army materiel systems and concepts for their employment conform to the capabilities and limitations of the fully equipped soldier, operating, and maintaining the materiel in an operational environment.

- o Assist the Army trainer in determining, designing, developing, and conducting sufficient, necessary, and integrated Army training.

- o Improve control of total life-cycle costs of soldier/machine systems by assuring consideration of the costs of personnel resources and training for alternative systems during the conceptual stages and for the selected system during subsequent stages.

1.7 THE INDUSTRY-ARMY PARTNERSHIP

The Army wants industry to consider the following question as they allocate functions among soldiers and machines.

> "Can this soldier, with this training, perform these tasks, to these standards under these conditions?"

This means that the Army must provide guidance to its contractors. It must portray "this soldier" in terms of skills, aptitudes, capabilities and training regimens, etc.

Armed with this information, industry will be expected to assure the Army that "this soldier" will be able to perform the functions allocated to him as a result of the design.

The issue of personnel supportability must be addressed by the Army as changes occur:

> "Can the Army personnel community support the force structure needs imposed by this system; namely, can it recruit, train and distribute the right soldiers at the right time?"

The emphasis on the above questions shifts as a program roves from program initiation (PI) to the various decision milestones of the acquisition process. In the early stages the MANPRINT effort is system oriented. It seeks to integrate human performance capability and reliability into total system performance through design influence. As the system moves to demonstration and validation and full-scale development the ability to influence design lessens and the effort becomes more unit oriented, and focuses on recruiting, training, distribution and otherwise providing for the support functions to effect further reductions in life-cycle costs.

If the goals and constraints provided early on are met, then answering the second question should be easier. Throughout an acquisition, MANPRINT guidance must be updated, and the above questions must be asked again.

MANPRINT CHANGES IN FOCUS AND ORIENTATION AS THE SYSTEM DEVELOPS

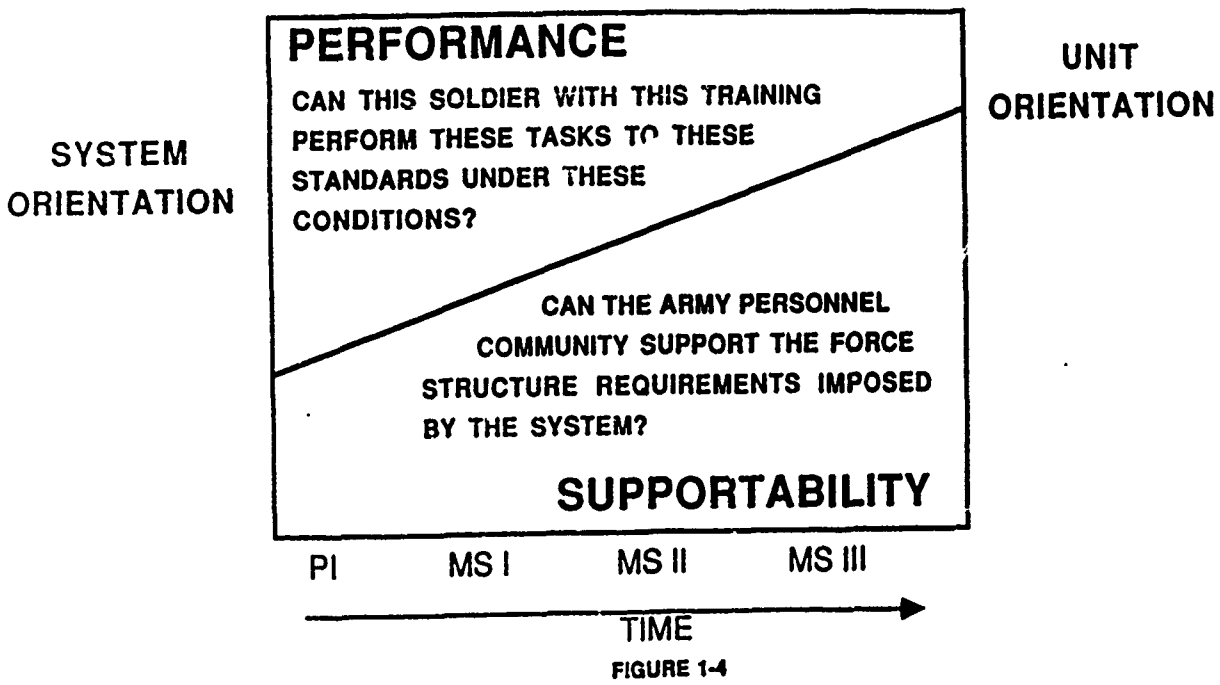

FIGURE 1-4

Figure 1-4. MANPRINT Changes in Focus as the System Develops

1.8 CONCLUSION

The MANPRINT program provides the means through the identification of objectives, goals and constraints in each of the six MANPRINT domains to effectively manage the integration of human performance and reliability considerations in systems development. The program begins early in the system development process to ensure proper tradeoff and integration of force structure and operational environment, engineering and technology, and soldiers. The orientation is always on achieving the goal of optimum total system performance. To achieve this goal and fulfill the MANPRINT objectives, the Army agencies and industry involved in system development and materiel acquisition must be aware of their responsibilities and effectively manage their part of the MANPRINT program. The following chapters will lay out the responsibilities, interactions, and processes which should take place.

CHAPTER 2
MANPRINT ROLES AND RESPONSIBILITIES

2.1 APPROACH

Among the key participants in the materiel acquisition process are combat developers, materiel developers, researchers, training developers, logisticians, and industry management. Early MANPRINT efforts are led by TRADOC through concept exploration. AMC and the PM lead through production and fielding. Each must deal with many factors of the program to reach execution and subsequent industry involvement with each program. This requires continual communication and interaction.

MANPRINT does not reduce current mission responsibilities but forms an interactive and mutually interdependent process to improve system performance. As the development process matures, through joint government and industry effort, MANPRINT seeks to assure that original influences remain despite the potential for changes in the production phase. The MANPRINT initiative supports high-level advocacy to the acquisition process by providing a variety of options (e.g., alternatives for balancing training, force structure, manpower, personnel, and equipment burdens) to key decision makers.

Active participation by both government and industry is the cornerstone to successful application of MANPRINT, and results in the best designed and most supportable system possible.

The MANPRINT program calls for a parallel, coordinated management and technical effort on the part of industry. A discussion of the roles and responsibilities of industry follows in the last section of this chapter.

2.2 ORGANIZATIONAL RESPONSIBILITIES

Chapter 2 of AR 602-2 provides a full description of the MANPRINT responsibilities for each Army organization. The following discussion only highlights organizational roles and responsibilities.

2.2.1 Headquarters, Department of the Army (HQDA)

a. Office of Deputy Chief of Staff for Personnel (ODCSPER) has primary DA staff responsibility for the MANPRINT program. They develop, coordinate and disseminate MANPRINT program policy and guidance to all Army commands and agencies.

ODCSPER reviews requirements documents, acquisition plans and materiel objectives to assure MANPRINT progress. Two agencies conduct behavioral research for ODCSPER: the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI); and the U.S. Army Human Engineering Laboratory (HEL).

b. Office of Deputy Chief of Staff for Logistics (ODCSLOG) assures that MANPRINT is integrated with the ILS process by establishing the appropriate logistics policy and guidance.

c. The Assistant Secretary of the Army for Research, Development, and Acquisition (SARDA) has Department of the Army (DA) responsibility for the research, development, and acquisition of Army materiel. SARDA establishes Army materiel acquisition policies and ensures MANPRINT is considered during the science and technology portions of RDTE (categories 6.1, 6.2, and 6.3). SARDA provides staff assistance to the AAE and, as authorized by the AAE, provides advice and counsel to PEOs and PMs.

d. Office of Deputy Chief of Staff for Operations and Plans (ODCSOPS) has staff responsibility for the operational arm of the Army, ensuring that MANPRINT is included during the preparation of requirement documents and in the review of acquisition objectives.

Additionally, ODCSOPS ensures that MANPRINT data is included in training device requirements and all training plans (institutional, unit, and joint service).

ODCSOPS ensures MANPRINT issues are addressed in user testing. ODCSOPS must ensure an available force structure for new materiel fielding, so they must ensure that MANPRINT is considered in BOIP/QQPRI policy (AR 71-2).

e. The Office of the Surgeon General (OTSG). The OTSG has staff responsibility for consultation and advice on medical aspects, particularly health hazard assessments, psychological considerations, health lessons learned, constraints and guidelines. They coordinate with appropriate Army Medical Department (AMEDD) agencies and commands to accomplish health hazard assessments for inclusion in HFEA's; the OTSG is the approval authority for all health hazard assessment reports. Through the Army Environmental Hygiene Agency (AEHA) and the Medical Research and Development Command (MRDC), the OTSG develops medical and health standards, data bases needed to support HFEA in Army systems, and monitors the application of biomedical and health standards throughout the materiel development and acquisition cycle.

f. Combat and training developers consider MANPRINT implications during the course of doctrinal, combat, and training developments. The Training and Doctrine Command (TRADOC) is the Army's principal combat and training developer (AR 71-9). CBTDEVs

represent the needs of the soldiers who will actually use the equipment. MANPRINT goals and constraints are identified by the CBTDEV, refined and incorporated in user requirement documents (the Operational and Organizational (O&O) plan and the Required Operational Capability (ROC) are but two of the requirement documents). Detailed human performance parameters are included in the requirement documents to assure a total system (soldier-in-the-loop) perspective is achieved during the design and development of materiel. CBTDEVs will normally prepare a Target Audience Description (TAD) which identifies the characteristics of the typical operator, maintenance, and support personnel. The TAD is an appendix to the System MANPRINT Management Plan (SMMP). Combat and training developers ensure that critical MANPRINT issues and criteria are included in operational test plans to determine if the target audience, under an operational scenario, is able to perform its tasks to an acceptable standard. Training developers perform studies and analyses to determine the effectiveness and efficiency of current and proposed training programs. They also prepare the system training plan (STRAP) and review the new equipment training plan (NETP).

g. Materiel developers (MATDEVs) provide the interface between the CBTDEV and industry (the Army Materiel Command (AMC) is the Army's principal MATDEV). The MATDEV transcribes user requirements, including MANPRINT goals and constraints, into contractual documents and closely monitors industry's compliance. The MATDEV's integrated logistic support (ILS) plan and the CBTDEV's SMMP are complementary documents. Each outlines information and procedures that virtually assure a successful materiel acquisition (the essentials of the SMMP are normally reflected in the ILS plan). The MATDEV will include MANPRINT issues and criteria in test and evaluation plans and recommend RDTE in the field of personnel education and training (AR 70-1, AR 71-9). When preparing the Government's Request for Proposal (RFP), the MATDEV solicits comments and assistance from the CBTDEV, ARI, HEL and other interested agencies to ensure all critical MANPRINT requirements appear in the statement of work (SOW), evaluation factors for award, and the system specification. This unified effort is required to assure that human considerations are not inadvertently overlooked nor arbitrarily traded-off. MATDEVs (Commodity Commands) provide functional support to PEOs and PMs. This support includes personnel, technical requirements planning, cost analysis, training, and MANPRINT. MATDEVs may on

occasion act as agents on behalf of the AAE (AAE Policy Memorandum #87-7).

h. The U.S. Army Operational Test and Evaluation Agency (OTEA) is the Army's independent tester and evaluator. OTEA's evaluation of test results serves to identify MANPRINT-related human performance problems. These may include errors and/or difficulties encountered in both the operation and maintenance of equipment. An error analysis may indicate the need for improved training procedures, higher quality personnel, equipment modification or redesign.

i. Program Executive Officers (.d separately reporting PMs, e.g., PM LHX) report directly to the AAE. They charter, rate, and supervise assigned program, project, and product managers (PMs). PEOs provide PMs the planning guidance, direction, control, and support necessary to field their materiel systems within the cost, schedule, and performance baselines. PEOs establish a close liaison with their CBTDEV counterpart to ensure user satisfaction. They are responsible for monitoring contractor performance and ensuring that MANPRINT considerations are properly addressed during system development. PEOs may be either general officers or civilian personnel of equivalent rank (members of the Senior Executive Service).

j. PMs are responsible for the development, procurement, production, fielding, and integrated logistic support of Army materiel (AR 70-17). As defined in their charter, PMs exercise full-line authority over the planning, organization, direction, and control over the approved program, project, or product. Resource allocation and utilization, too, are under the PM's purview. PMs develop acquisition strategies that are advantageous to the Government. To achieve cost goals or savings in life-cycle ownership costs, PMs may execute trade-offs within the bands of performance specified in the ROC (provided such trade-offs do not breach established thresholds). PMs are responsible for providing cost, scheduling, and logistical data to support the CBTDEVs' COEA preparation. As a result of the recent Army reorganization, the PM's reporting channel has been streamlined (see figure 2-2). Full-time support to the PMs is provided through the personnel assigned to each PM office (PMO). As defined in each charter, PMs have tasking authority over outside agencies.

k. TRADOC System Managers (TSMs) are the CBTDEV's counterpart to the PM. TSMs are appointed and chartered by the TRADOC commander for selected major

and designated acquisition programs. They are appointed early in the development cycle, normally at the time a PM is appointed. The TSM is the focal point for the coordination of CBTDEV, training developer, and user efforts in the development and acquisition of Army materiel. If there is no assigned TSM, the Director of Combat Developments (DCD) at the proponent school or center serves as the focal point (AMC/TRADOC Pam 70-2).

2.2.2 Industry

Management and technical efforts within industry must run parallel to those of the Army by integrating MANPRINT both organizationally and technically into the system design process. This integration could potentially be carried out through any one of several organizational chains dependent on a given contractor's current structure.

In planning for MANPRINT application within current structure, it is extremely important that a thorough audit trail mechanism be established since MANPRINT audit implications on design and supporting decisions are iterative in nature.

Several key issues outlines below must be applied and tailored somewhat, depending on acquisition phase, strategy, and system complexity.

a. Anticipate human performance and reliability issues associated with future designs or changes to existing design.

b. Communicate the contract MANPRINT requirements, including goals and constraints, target audience description, etc. to design engineers so as to influence design decisions.

c. Oversee the execution of MANPRINT requirements and advise top management of deficiencies so that corrective actions may be implemented.

d. Participate in design and other reviews to raise MANPRINT issues and to assess MANPRINT progress.

e. Conduct the various MANPRINT analyses called for in the MANPRINT Statement of Work and in specifications or oversee their conduct if the function is conducted by other than a dedicated MANPRINT organization.

f. Examine the interrelationships among the six domains and raise the interconnectivity issues for consideration in such design activities as functional allocation.

g. Participate in development of test and evaluation plans to assure that the validation of MANPRINT requirements is built into the overall test evaluation program.

h. Develop the analytical techniques and employ established analytical techniques as required to conduct the contractually stipulated MANPRINT program.

i. Actively participate in joint meetings with the Army to address key tradeoff decisions and the effects on system effectiveness and overall system performance specifications.

2.2.3 Conclusion

The successful integration of MANPRINT requires a team effort. Within the Army, all players must do their part individually and collectively in order to successfully communicate internally as well as externally to industry. Industry is a key member of the team and must ensure that they are organizationally prepared to deal with MANPRINT and that MANPRINT is integrated into the system engineering process.

The roles of Army and industry are illustrated in Figure 2-1. The Army establishes the requirement for industry and maintains a dialogue throughout the acquisition process. Industry is encouraged to develop innovative solutions to arrive at optimal human and equipment performance (P_H and P_E). The total system performance is continuously evaluated throughout the process to ensure MANPRINT goals and constraints are met.

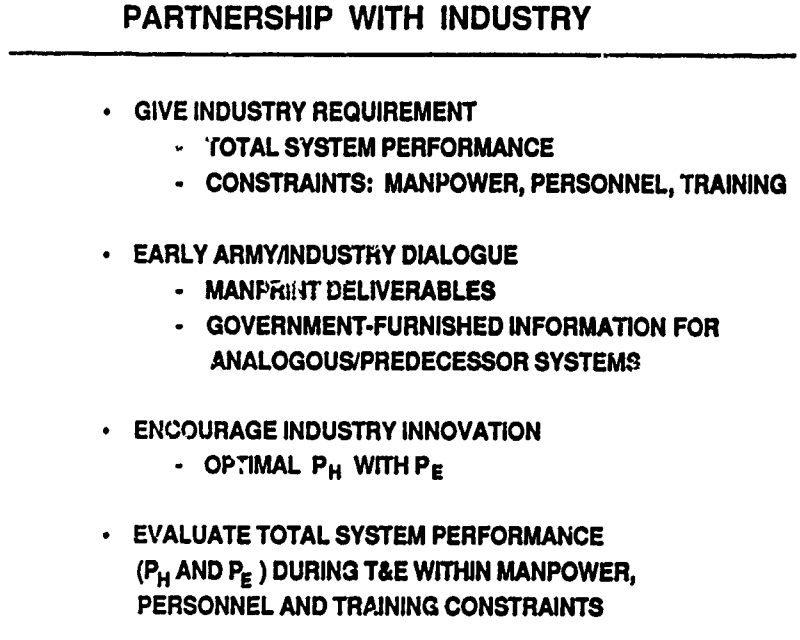

Figure 2-1. Partnership With Industry

CHAPTER 3
PROGRAM MANAGEMENT

3.1 INTRODUCTION

MANPRINT requires a comprehensive management and technical effort, starting before program initiation and extending throughout the system life cycle. This chapter focuses on several aspects of MANPRINT program management, applicable both to the Army and industry, including the traditional elements of cost, schedule and performance. MANPRINT management and timing emphasizes scheduling activities early in the acquisition process. These activities are documented by the MANPRINT Joint Working Group (MJWG), an interdisciplinary organization, in the System MANPRINT Management Plan (SMMP) activities. The resources required to conduct the MANPRINT related studies and analyses are identified and become the basis for MANPRINT-oriented funding requests.

3.2 PROGRAM MANAGEMENT AND TIMING

3.2.1 An effective MANPRINT program depends on a total understanding of life-cycle system acquisition model and the need to provide MANPRINT inputs at the right time. During the earliest phase of the development cycle--up to milestone I--TRADOC is responsible for MANPRINT leadership. In a 20 August 1986 letter, TRADOC Headquarters (DCSCD) issued detailed guidance to the TRADOC integrating centers and proponent schools for planning and executing a MANPRINT program during system acquisition. The guidance is time-oriented and portrays the activities and inputs required to implement MANPRINT.

Of equal importance is the preparation required to permit the MANPRINT element of the materiel developer's office to provide timely input to industry via the Request for Proposal (RFP). Input includes inserts into the statement of work (SOW), input to the system specifications, selection and tailoring of data item descriptions (DID) and development of contract data requirements lists (CDRL), which include MANPRINT related reports. Industry should be provided draft requirement documents and RFP's for review and comment. Soliciting industry comments early aids in establishment of reasonable requirements for all materiel acquisition participants.

3.2.2 To illustrate the criticality of timing, it is useful to examine the MANPRINT activities prescribed for the Requirements and Technology Base Phase of the Army Streamlined Acquisition Process. The activities and their milestones as contained in the TRADOC document are

(1) The decision to seek a materiel solution to a battlefield deficiency starts the process. The first documents required are the "System MANPRINT Management Plan (SMMP) and Organizational and Operational (O&O) Plan."

(2) The following activities must occur three to six months prior to program initiation to provide requisite MANPRINT input to requirements documents:

(a) Identify data sources and conduct a literature review to obtain raw data for analysis and as input to define future actions.

(b) Convene a MANPRINT Joint Working Group (MJWG) and initiate the System MANPRINT Management Plan (SMMP) to provide management control for all future MANPRINT actions.

(c) Determine if a HARDMAN (Hardware vs. Manpower) analysis is required and make arrangements for its conduct and funding.

(3) The following activities must occur within the 3 months of submission of the O&O Plan.

(a) Conduct an Early Comparability Analysis (ECA) to provide essential manpower, personnel, and training (MPT) data for developing inputs to SMMP and O&O Plan. This will be discussed in detail later.

(b) Determine the type of operational units, that will employ and support the new system. Include plans for the displaced system as input to the O&O Plan. Also, provide the manpower and personnel constraints, plus environmental conditions, doctrine and tactics to be considered.

(c) Provide manpower and personnel issues for input to Human Factors Engineering Analysis (HFEA).

(d) Develop a Target Audience Description (TAD). Describe for the Army and subsequently the contractor, the quantity and quality of the soldiers and/or civilians who will operate, maintain and support the system.

(e) Provide MANPRINT issues which will influence design of the system or those manpower and personnel aspects that will be affected by the new system.

(f) Provide estimate of manpower, personnel, and training impacts for each alternative including the monetary costs of these impacts as input to Cost and Operational Effectiveness Analysis (COEA).

(g) Provide the Target Audience Description and MANPRINT issues and criteria for input to Test and Evaluation Master Plan (TEMP).

(h) Provide information derived from ECA for input to the Logistics Support Analysis (LSA).

Because of the variety of MANPRINT requirements as shown above, and the need to meet specific milestones, it is imperative to structure an organization to plan this interdisciplinary effort. The goal is to conduct, in advance, the data collection, analyses and planning required to be ready with MANPRINT contribution precisely when it is required. The MANPRINT Joint Working Group (MJWG) is the organizational entity selected for the job. The System MANPRINT Management Plan (SMMP) is developed as the master planning document for MANPRINT.

3.3 ORGANIZATION FOR MANPRINT - ARMY

MANPRINT Joint Working Group (MJWG) - The MJWG is convened three to six months prior to the submission of the O&O Plan. The MJWG is established by the TRADOC proponent combat developer at the proponent school/center and is responsible for planning all MANPRINT inputs and activities for the entire system life cycle. The MJWG manages all MANPRINT issues and provides oversight to ensure that MANPRINT plans are executed and objectives met.

Representation on the MJWG for any system is determined by the proponent based on available assets and the nature of the acquisition. Representation will be sought from within the TRADOC proponent school to include, as a minimum, the Directorate of Combat Development, Directorate of Training and Doctrine, Directorate of Evaluation and Standardization, Safety Office and the Proponency Office. A health hazard representative should come from the installation medical treatment facility. Outside representation should include AMC elements, Human Engineering Laboratory, DCSPER's Army Research Institute for the Behavioral and Social Sciences (ARI), plus other proponent schools and the TRADOC integrating centers.

AMC participation is particularly important to reinforce the linkage between the Battlefield Development Plan (BDP), the Mission Area Material Plan (MAMP), and the Long-Range Research and Development Plan (LRRDAP). This facilitates influence of Technology Base management, insertion of MANPRINT issues into the Tech Base work, and identifying MANPRINT funding needs through the LRRDAP process (see section 3.7). In addition, AMC representation is important since many of the tasks developed by the MJWG will have to be executed by AMC through its system contractual activity. Suggested membership is indicated in Figure 3-1.

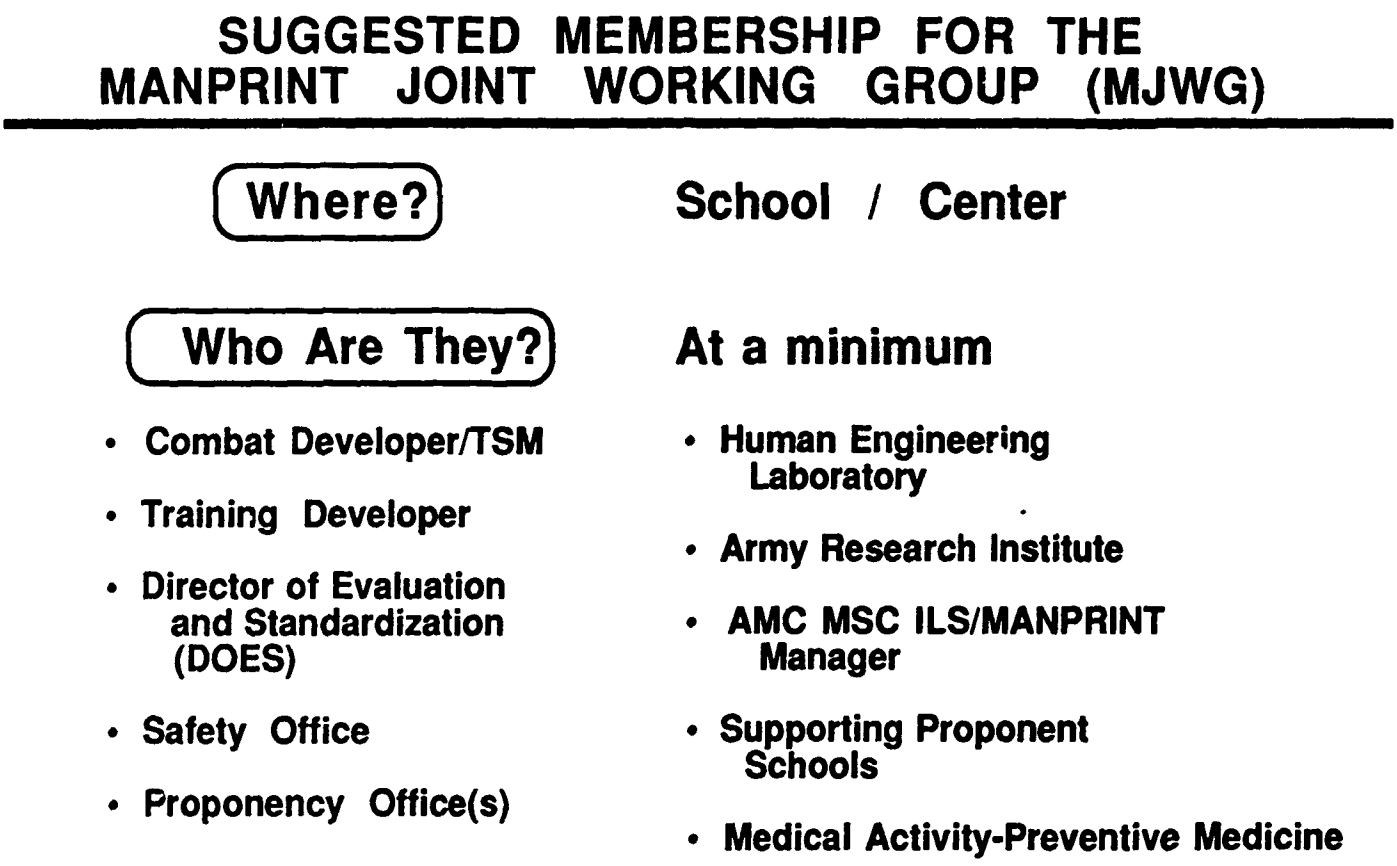

Figure 3-1. Suggested Membership for the MJWG

3.4 ORGANIZATION FOR MANPRINT - INDUSTRY

3.4.1 Organization

Just as effective MANPRINT activity within the Army is highly dependent on a total understanding of the life cycle system acquisition events and the ability to provide timely MANPRINT inputs, so to is industry's understanding of specific requirements in the design process. An overview of what the Army is looking for is provided in the sample MANPRINT evaluation criteria (see Appendix D). This information should prove useful in arriving at organizational decisions that are attuned to contract for MANPRINT requirements. Typically, the offeror's organization for and expertise in MANPRINT is included as an evaluation criteria in source selection.

Industry should prepare itself organizationally to integrate MANPRINT into the design process. Many companies already have organizations and expertise in place to deal with some of the individual domains. Generally, these include human factors engineering, training, systems safety and health hazards. Capability to address the manpower and personnel domains is less prevalent.

The Army does not want to dictate how and where industry should integrate MANPRINT. Any number of potential approaches may be taken. MANPRINT management may be assigned to the system engineering department, logistic department, training group, human factors engineering group, mission analysis cell or another appropriate organization. In addition to assigning management responsibility to a specific department or group, staffing may be augmented by internally matrixing other functional departments to provide support, by subcontracting MANPRINT managements to a professional service firm or by some combination of in-house management and subcontract as indicated in Figure 3-2. Indications that the corporate leadership is both aware of MANPRINT requirements and has included them in the technical solution to the requirement is an additional critical factor in the selection process.

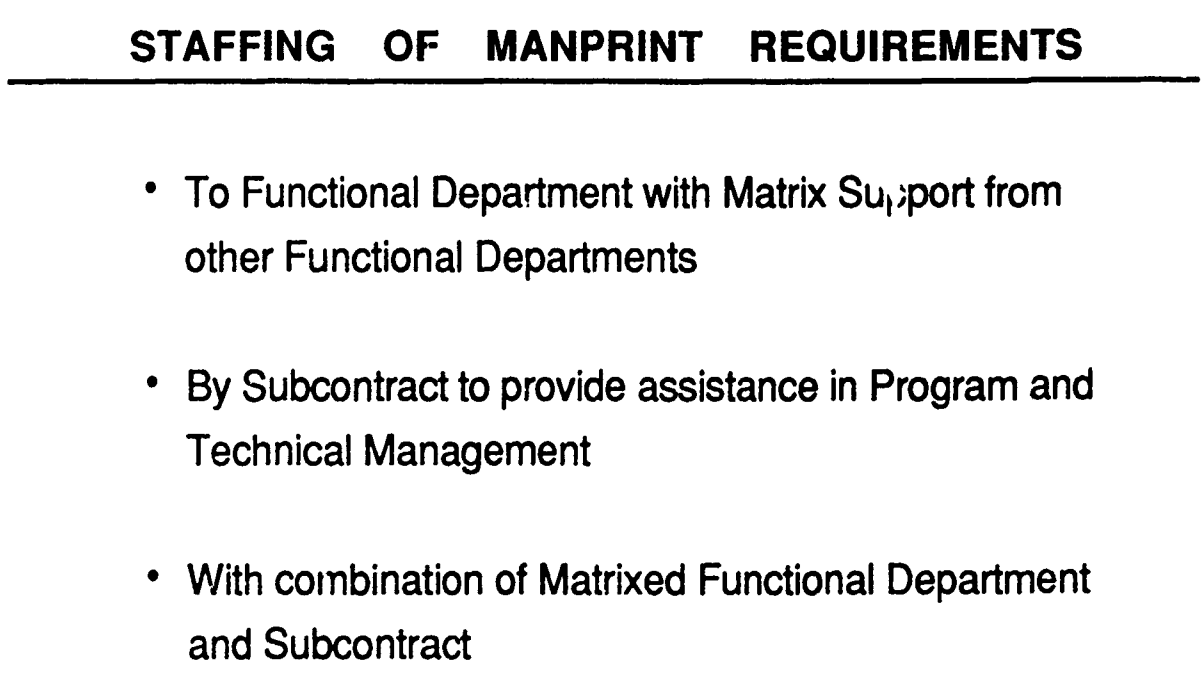

Figure 3-2. Staffing of MANPRINT Requirements

3.4.2 Industry Challenge

Figure 3-3 summarizes the organizational and technical challenges facing industry. To meet these challenges, industry may decide to form an organization similar to the Army's MJWG. This organization would assemble its MANPRINT tool box. Tasks would include traditional human factors engineering and logistic support analysis tools supplemented by Army-developed manpower, personnel, and training tools. Specific analyses may be subcontracted. In addition, Independent Research and Development (IR&D) might be initiated to develop new, contractor-specific tools. These analyses would be conducted to identify MANPRINT issues that may impact on system engineering.

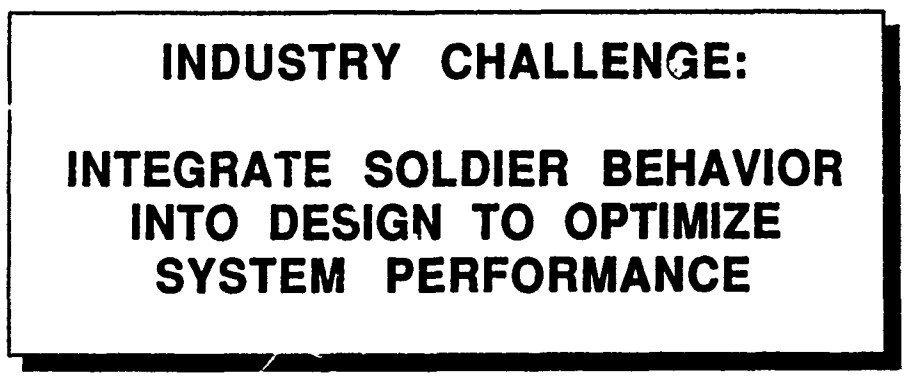

Figure 3-3. Industry Challenge

Activities for both the Army and industry should be documented in a master plan.

3.5 SYSTEM MANPRINT MANAGEMENT PLAN (SMMP)

Within the Army, the SMMP is the master planning document for MANPRINT activities during system development and is updated as needed throughout the acquisition process. The procedures and format for developing an SMMP are described in AR 602-2 and the SMMP Procedural Guide. It is the first program management document in the entire acquisition cycle and is initially prepared by the MJWG in the same timeframe as the O&O preparation. SMMP users include Army staff, TSMs/combat developers, PMs/materiel developers, training developers, logisticians, testers, evaluators and individual practitioners in each MANPRINT domain.

The SMMP lays out the MANPRINT goals and constraints, the issues, the areas of concern, data needs, data sources, analyses, tradeoffs, milestones and decisions that must be made to ensure that MANPRINT is considered in the acquisition process. It is recognized that the SMMP may be rudimentary during its initial phase but will grow in content and specificity as the system development proceeds.

The SMMP is an input document for requirement documents, key program management documents, and finally the request for proposal, as reflected in figure 3-4.

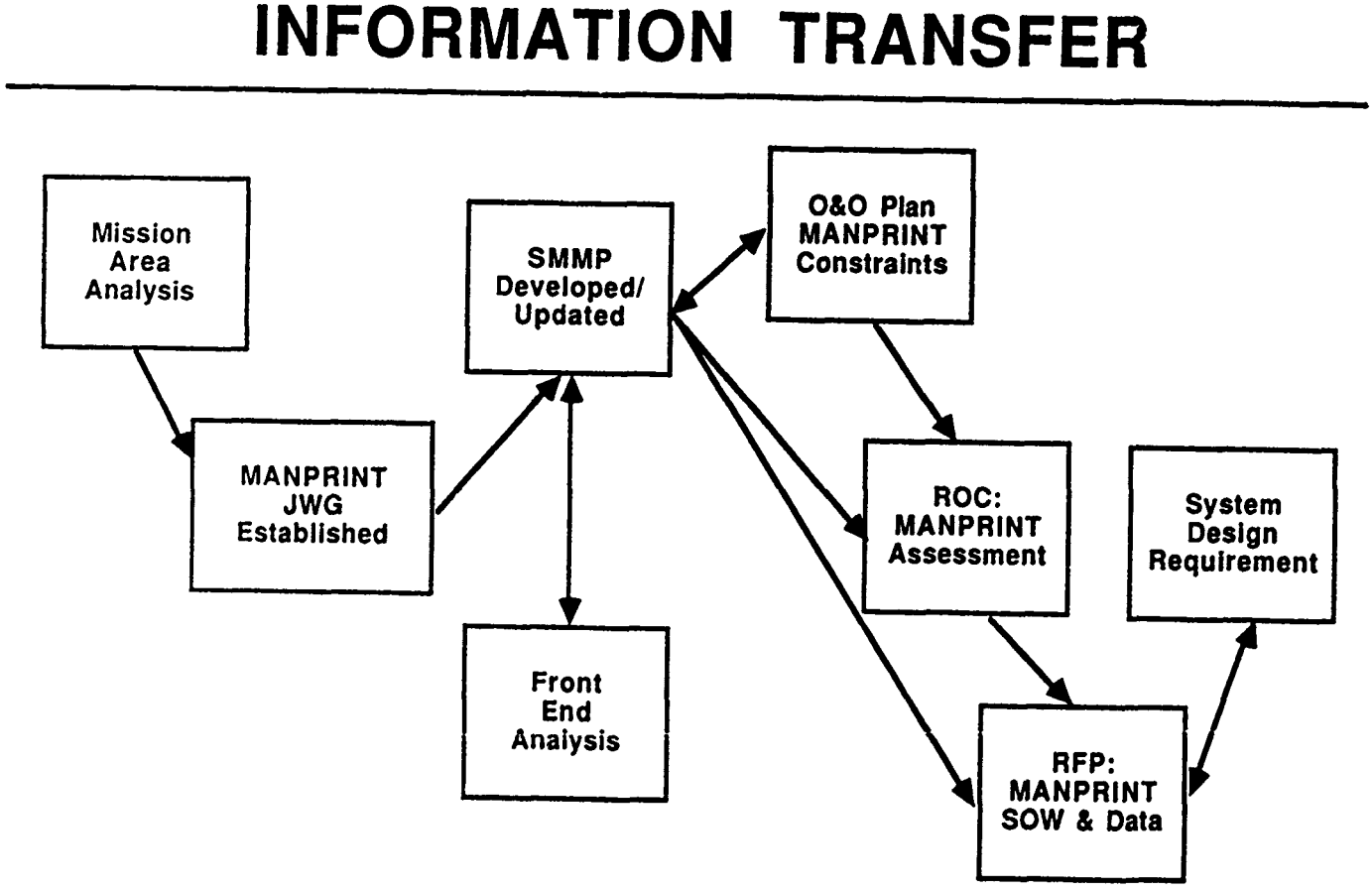

Figure 3-4. Information Transfer

In developing the SMMP, the MJWG structures a MANPRINT effort to address these fundamental questions:

1) What program decisions do we need to influence?

2) What data or information do we need for analysis to provide the basis for a MANPRINT decision?

3) How do we plan to get that data or information?

4) How will we use the results of the analyses to influence the decision or activities?

5) The impact of acquisition strategy on information requirements, generation, and management?

For more details on the SMMP, the Soldier Support Center (National Capitol Region) has prepared the System MANPRINT Management Plan (SMMP) Procedural Guide, dated 1 July 1986.[1] This document provides both procedural instructions and an example of a comprehensive SMMP for a development item.

3.6 SYSTEM MANPRINT MANAGEMENT PLAN (SMMP) - INDUSTRY

Industry has already accomplished a great deal in developing and engineering new technology. MANPRINT should be considered by the contractor in their efforts prior to receiving a contract. The contractor will also be required to develop a plan for accomplishing MANPRINT. MANPRINT goals, constraints data and analyses should be identified in the request for proposal. The industry SMMP should serve as a planning and management guide and an audit trail to identify the tasks, analyses, tradeoffs, deliverables and recommendations that must be made to address MANPRINT issues during system design. Industry's version of the MJWG would be responsible for developing the contractor SMMP. The industry SMMP should reflect the contractor's plans and program to accomplish the Army's MANPRINT goals and requirements.

3.7 MANPRINT PROGRAM MANAGEMENT AND PRODUCT IMPROVEMENT

For details governing product improvement policy and procedures, see AR 70-15, Product Improvement of Materiel. Product improvements can be very consequential in affecting MANPRINT domains. The AMC MANPRINT Coordinators should remain cognizant of the status of PIP Alerts which are channelled through the Configuration Review Board prior to circulation for review by other activities. The MANPRINT issues must be considered in the configuration decision. The Front-End Analysis (FEA) should be revisited in light of the product

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1 For more information on the SMMP Procedural Guide, contact Deputy Commander, USASSC-NCR, ATTN: ATNC-NMF-B, 200 Stovall Street, Alexandria, VA 22332-0400 (Autovon 221-0395/0457 or commercial (703) 325-0395/0457).

improvement. Changes from the original baseline should be identified and assessed. A determination should be made as to whether the original MANPRINT goals and constraints may be breached because of the extent and nature of the PIP. The MANPRINT sensitivities should be explored.

When it is agreed that a PIP should proceed for approval and funding, the Product Improvement Management Information Report (PRIMIR) is the basic document and report on a PIP. The PRIMIR is the document used in the prioritization process. MANPRINT issues and concerns should be included in the PRIMIR particularly where it is judged that MANPRINT issues are a primary reason for desiring PIP approval. It is noted that concepts approval, technical approval and funding approval are required to carry out a proposed PIP.

3.8 MANPRINT PROGRAM MANAGEMENT AND NON-DEVELOPMENTAL ITEMS (NDI)

NDI is a generic term that covers materiel available from a variety of sources with little or no developmental effort by the Army. NDIs are normally selected from:

1. Commercial sources (may require ruggedization or militarization).

2. Materiel developed and in use by other U.S. Military Services or Government agencies.

3. Materiel developed and in use by other countries.

The MANPRINT Coordinator needs to be concerned with the following general NDI categories:

1. Category A - Off-the-shelf items to be used in the same environment as commercial use.

2. Category B - Off-the-shelf items to be used in a military environment substantially different than the commercial environment.

3. Other - A new system assembled from components (commercial market/other services/foreign). The system may require some hardware/software development.

NDI is growing in importance as a method of supplying Army systems and equipment. NDI procurements can be both large in dollar value and receive Army-wide distribution. Market investigation is called for early in the concept formulation phase to assess the availability and viability of NDI as an alternative acquisition strategy preferred over new system development. While MANPRINT in an NDI cannot influence design except where modifications are approved, it can become a critical discriminator in deciding whether an NDI strategy should be approved by the decision body.

An eventual NDI program starts in the same way as any other program, namely, with the identification of a deficiency through the MAA, followed by the development of an SMMP by the MJWG and an O&O Plan. The SMMP MANPRINT goals and constraints, issues, areas of concern, analyses, and trade-offs are used during the market investigation to determine whether any equipment available in the marketplace meets Army requirements, to include MANPRINT requirements (see figure 3-5).

THE NDI DECISION PROCESS

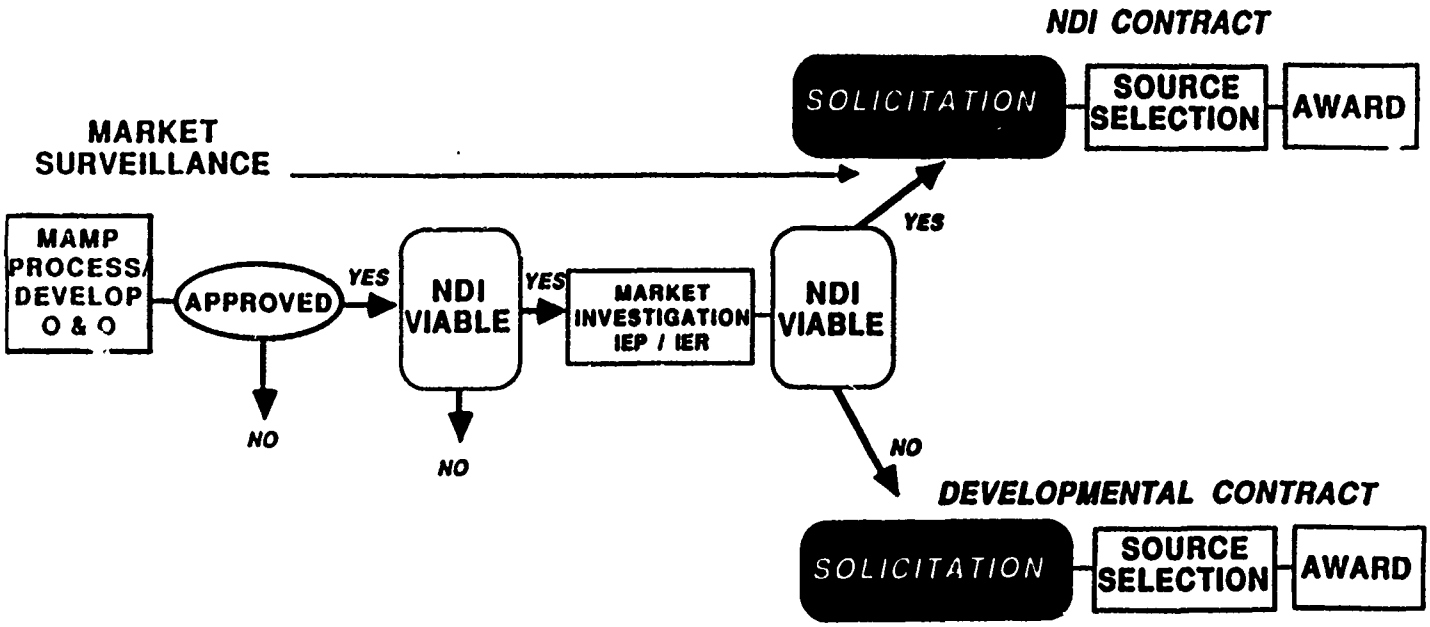


Figure 3-5. The NDI Decision Process

The key to assuring that MANPRINT is considered in NDI acquisition is to insure that MANPRINT issues are inserted into the Independent Evaluation Plan (IEP) by the combat developer. Sample MANPRINT NDI questions are:

- o General

  What is the warranty history?

  - Types of deficiencies
  - Volume of deficiencies

- o Manpower

  Did you conduct task workload analysis to arrive at operator and maintainer requirements?

- o Personnel

  What was the target audience you had in mind in designing the product?

  - Cognitive skills
  - Experience background
  - Proficiency levels of operators/maintainers

- o Training

  - Did you apply any training constraints to influence design?
  - What is your operator/maintainer training program?
  - How do you handle sustainment training?
  - Do you have a customer training program?
  - Are training devices used?
  - Have any training problems surfaced in the marketplace?

- o Human Factors Engineering

  - What HFE standards/requirements were applied in your product design?
  - How did HFE consideration influence your design?
  - What HFE problems have surfaced in the marketplace?

- o System Safety/Health Hazards

  - What system safety and health standards were applied in your product design?
  - What were the programs surfaced during your tests and early fielding?
  - What problems have surfaced in the marketplace?

By gathering the required data and information from a variety of sources and by visits (if needed) to manufacturers and users, the issues are addressed and included in the Independent Evaluation Report (IER) which assists the decision makers in deciding on NDI viability. AMC/TRADOC Pamphlet 70-7, Non-Development Items/NDI provides comprehensive guidance on NDI acquisition including MANPRINT.

It should be kept in mind that for commercial, off-the-shelf equipment, the marketplace data and information will have to be expertly assessed to determine if Army MANPRINT requirements have been met. For example, it may be necessary to judge if commercial warranty data and Industry reliability test data will provide sufficient evidence that Army reliability requirements will be met. From a MANPRINT standpoint, a Human Factors Engineering Analysis (HFEA) should be conducted so that experts in each MANPRINT domain will provide an assessment of how well marketplace equipment complies with MANPRINT requirements. Sample MANPRINT NDI issues to be resolved by decision makers are at Figure 3-6.

ARMY MANPRINT ISSUES TO BE RESOLVED FOR IPR DECISION

- Will goals and constraints be breached?
  -Magnitude? Impact?
- Can Target Audience operate and maintain the NDI?
- Will "high drivers" be eliminated or reduced?
- What human factors engineering factors have been incorporated?
- Are Army safety, health and environmental requirements met?
- Have the issues and concerns, as laid out in the SMMP, been resolved?

Figure 3-6. Questions - Typical Market Investigation

For NDI consisting of already developed equipment (i.e. other services, foreign, etc.) a great deal of data and information will have been derived during the development process. Here again the data and information needs of the SMMP should be matched against that which is available. An HFEA should be conducted as discussed above and the MANPRINT issues should be included in the IEP and assessed in the IER.

If critical MANPRINT issues, questions and concerns cannot be addressed because of lack of data or other reasons, additional effort may be required before the NDI decision is made. For example, if important enough the NDI decision could be delayed, sample equipment could be purchased, and a test and evaluation could be conducted to obtain data for analysis to

answer the critical issues, i.e. who is the target audience, what is training experience, and what manuals are available. AMC, TRADOC and the Logistics Evaluation Agency (LEA) must consider MANPRINT in arriving at a command position for the In-Process Review (IPR) where the approval of an NDI strategy will be sought.

Each appropriate MANPRINT Coordinator should be deeply involved throughout the Market Investigation process and should influence the command position for the IPR from the MANPRINT point of view.

3.9 MANPRINT FUNDING

3.9.1 General

Implementation of an effective MANPRINT Program requires resources--people and money. MANPRINT program management may require more money up front for information that results from analyses, studies, assessments and evaluations. Examples include Early Comparability Analysis (ECA), HARDMAN, Use Study, Comparative Analysis, Workload Analysis, Task Analysis, System Safety Tasks, Training Effectiveness Analysis (TEA) and Human Factors Engineering Analysis (HFEA), to name a few. A key document in determining MANPRINT program management information requirements is the System MANPRINT Plan (SMMP). All these studies, analyses and evaluations require resources. Some may be done by the Army, some by the equipment contractor and some by professional service firms. The latter two will require funding and a contract. The purpose of this section is to discuss getting funding to support MANPRINT management.

The ability to effectively plan and budget for the MANPRINT tasks and analyses is ultimately a matter of identification of requirements, the development of sound cost estimates and the timely inclusion of these funds into the programming and budgeting process. For such Front-End Analysis such as ECA or a HARDMAN, TRADOC must build these needs into the appropriate TRADOC budget line. For those tasks and analyses identified in the SMMP for conduct after program initiation (O&O Plan approval) the MANPRINT requirements should be integrated into the tasks and analyses required for the system and funded by the appropriate command or agency. While MANPRINT dollars will not be separately identified, it will be recognized by the materiel developer that, like ILS, MANPRINT dollars are included in the overall funding. This will enhance the MANPRINT community's ability to assure that the SMMP tasks and analyses are accomplished during contract performance. The MJWG should also be prepared to deal with trade-offs of tasks and analyses, or work-a-rounds if it develops that all of the desired funding is not obtainable.

From an industry standpoint, there should be an awareness of the type of task and analyses that they may come to expect as MANPRINT makes its contractual impact. Consideration should be given to the development of analytical tools under the aegis

of the Independent Research and Development (IR&D) program to acquire the analytic tools needed for MANPRINT work. Contractors should also develop a menu of existing and modified analytical tools to be in a position to respond competently and effectively to MANPRINT requirements in Requests for Proposal (RFP). MANPRINT responses will not stand up in the evaluation process unless these techniques are adequately described and properly costed.

3.9.2 Planning and Programming

The Army budget process is called PPBES--Planning, Programming, Budgeting and Execution System--and requires sound prior planning. Funding requests are submitted to MACOMS--AMC and TRADOC for example--where they are consolidated into Program Development Increment Packages (PDIP), prioritized and submitted to HQDA. DA goes through the same process and provides funding to PDIP's based on priority. This process takes two years--making prior planning essential. As the PDIP serves as the basis to compete for funds, the justification for the funds must make a strong case for the resource requirement, in this case MANPRINT.

To successfully compete for funds requires planning, programming and articulating MANPRINT program management needs. The System MANPRINT Management Plan is the key planning and management document in developing a funding program. Paragraph 3.b(3) Planned Level of MANPRINT Analysis Effort, Tab B, Milestones, and Tab C, Task Requirements lay out what is needed and when it is needed.

3.9.3 RDT&E Funds

Funds for Research, Development, Test and Evaluation (RDT&E)--also called Program 6 funds--are a key source for MANPRINT program management. These are funds for both the Tech Base and PM's. RDT&E funds are generated through the Long-Range Research and Development Acquisition Plan (LRRDAP), which results in PDIP submissions to HQDA (see Figure 3-7). Both AMC and TRADOC participate in development of the LRRDAP and both have the opportunity to influence fund allocation for MANPRINT in the Tech Base and the PM's budget. Planning ahead for MANPRINT will facilitate programmed funding for MANPRINT. This is essential because a key source of MANPRINT funds should be the PM's budget. Examples of contract deliverables that should be funded by the PM are Human Factors Engineering data requirements, System Safety tasks and Training analyses.

APPROPRIATIONS:
RDT&E LRRDAP 87-2001

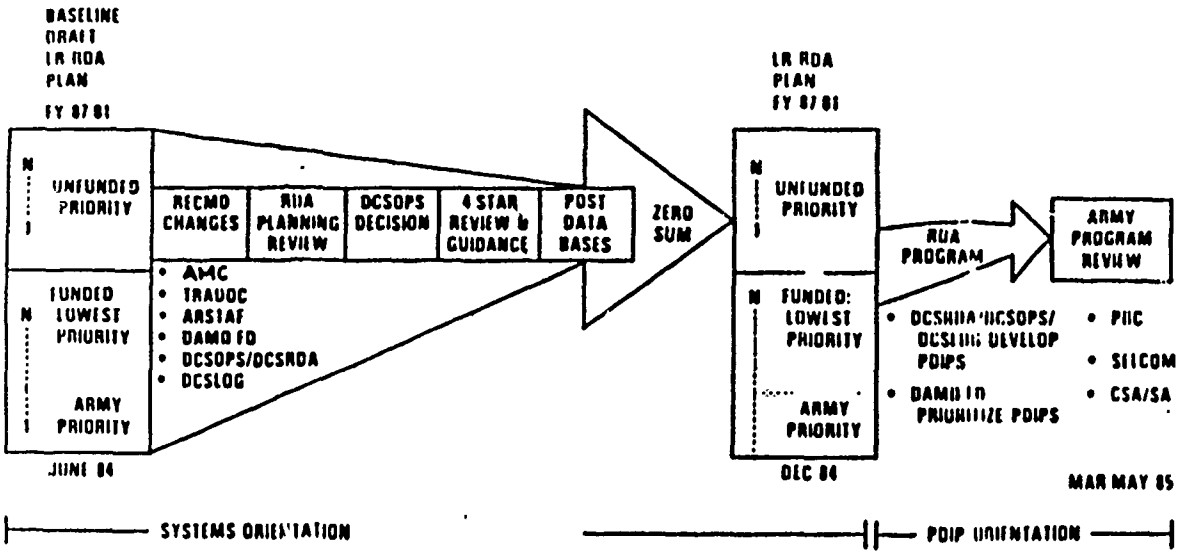


Figure 3-7. Appropriations: RDT&E & LRRDAP

3.9.4 TRADOC Funds

The PM's budget will normally fund the MANPRINT program after Milestone I. Prior to Milestone I, MANPRINT staff officers will require other sources of funds. As MANPRINT emphasizes front end analysis in order to influence system criteria and design, TRADOC's funding requirements begin prior to program initiation. Concurrent with the LRRDAP funding process, TRADOC proponent schools will be developing their own funding requirements. The proponent will normally submit issues to DCSCD, HQ TRADOC, which will prioritize them and incorporate them into PDIP's. These PDIP's can serve as the basis for funding ECA's, HARDMAN, TEA's, early LSA tasks such as Use Study and Comparative Analysis, and other pre Milestone I requirements. Because of the two year lead time, prior planning is essential.

3.9.5 Other Funding Sources

Other sources of MANPRINT funds include studies and analysis funds (AR 5-5); Concept Evaluation Program (CEP) funds; submission of unfinanced requirements if money has not been programmed or was programmed but of low priority and was unfunded; and networking with other Army agencies, such as HEL or ARI, by coordinating studies and analysis in areas of common interest.

3.9.5.1 Studies and Analysis Funds

TRADOC Reg. 11-8 and TRADOC Pam 11-8 outline the procedures for requesting studies and analysis money. These funds have been used to support Cost and Operational Effectiveness Analysis (COEA), Training Effectiveness Analysis (TEA) and Mission Area Analysis (MAA); they may also be appropriate for developing System MANPRINT Management Plans and conducting Early Comparability Analysis.

3.9.5.2 CEP and Test Funds

A limited source of funds for MANPRINT is the Concept Evaluation Program (CEP). CEP is a pre-program initiation TRADOC program which involves the use of specific RDT&E (TRADOC controlled) funds for a broad spectrum of tests and evaluations of new or modified hardware for assessment of doctrine, tactics, training and materiel usage concepts. CEP provides a simplified process for resolving and solidifying combat and training developer thinking. MANPRINT issues and concerns could be included in the CEP tests and evaluations. Other test money is generated by the Outline Test Plan (written shortly after program initiation) which is the resource document for time, people and materiel for testing and evaluation. Early identification of MANPRINT test issues and the resources required to properly test these issues is important if the resources are to be provided during test and evaluation.

3.10 SUMMARY

The keys to an effective MANPRINT program are teamwork, planning and communications. The MJWG provides the internal mechanism for pulling together the Army team; industry should have a similar organization. In the Army, the team establishes the requirement and program; in industry it executes the program by affecting design. Together Army and the contractor form the design team, each with their own special knowledge. The plan for executing the program is the SMMP and its industry equivalent. The SMMP serves as the basis for information flow for MANPRINT requirements. The plan must be developed early in the system life cycle and resources requested to execute the plan. The plan becomes the basis for identifying resource requirements and must be tailored based on resource availability. Finally, the key to effectiveness of the MJWG and the SMMP is internal communication in the Army and coordination between the Army and the contractor throughout the entire developmental process.

CHAPTER 4
TECHNICAL MANAGEMENT

4.1 INTRODUCTION

This chapter focuses on the management of MANPRINT from the technical standpoint. Technical management refers to the analyses and evaluations that are required to answer questions and address MANPRINT concerns. The purpose of technical management is to determine MANPRINT goals and constraints, develop designs that meet system performance requirements, and ultimately validate design requirements.

Concurrent with developing the MANPRINT technical management effort, the resources--money and people--must be identified and requested. When insufficient resources are available, then the technical management tasks must be prioritized considering the risk of not performing all the tasks. Those with the lowest risk and lowest priority may be unresourced and not performed. Thus, the desired technical management effort will be constrained.

For the Army, the technical management effort is part of the System MANPRINT Management Plan (SMMP) and should be described in paragraph 3 (MANPRINT Strategy) and Tabs A (Data Sources), B (MANPRINT Milestone Schedule), and C (Task Descriptions). The development of the technical management activities as well as the overall management plan is the responsibility of the MANPRINT Joint Working Group (MJWG). This chapter does not specify the technical management effort for industry, but does suggest analyses and evaluations that may be requested by the Government to be performed.

The following paragraphs will discuss the context of technical management efforts and the planning factors, issues and concerns specific to the integration of the MANPRINT domains, the MANPRINT analysis process, and the assessment of the return on investment.

4.2 PLANNING FACTORS

4.2.1 General

An essential aspect of technical management is total system definition. The total system footprint--soldiers, equipment, units, training systems, logistic systems, etc.--needs to be defined. The impact of the new system upon the larger force and supporting systems can then be more accurately assessed and the new system can be integrated into the larger system. All players--AMC, TRADOC, DOD and industry--must consider the interrelationships. The new system will interact with other systems in the combined arms force--tanks, personnel carriers, air defense weapons, etc.--in accordance with Army doctrine and organizational structure. AMC and TRADOC must ensure that equipment, force structure, doctrine and soldiers are compatible. The combined arms force must in turn be

capable of meeting the requirements of joint and combined forces.

To ensure consistency in the system integration process, common planning factors must be used throughout. Agreement must be reached on such factors as system performance standards, equipment densities, usage rates and replacement schemes. These planning factors must receive management visibility and consensus by all decision makers who are responsible for a particular program early in its development process. Once agreed to, these factors must be used consistently in conducting subsequent analyses.

4.2.2 Planning Guidance and Resources

At the joint service level, military planning is conducted within the framework of the Joint Strategic Planning System (JSPS). The JSPS is a continuing process which is reconciled biennually with defense guidance. In defense guidance the Secretary of Defense provides guidance on the threat, strategic objectives, national military objectives, and force and resources (manpower and dollars) to the military services. The defense guidance and Joint Strategic Planning System in turn complement the overall DOD Planning, Programming and Budgeting System (PPBS). DOD starts the process of linking guidance and resources.

The Army participates in this planning, programming and budgeting process. Based on defense guidance The Army Plan (TAP) publishes Army Guidance on the threat, strategy, resources, priorities and force structure. It provides guidance to the Army Staff and MACOMs for developing the program objective memorandum (POM), linking Army guidance to resources and the Army's Planning, Programming, Budgeting, and Execution System (PPBES). The Army Plan also becomes the basis for conducting the Total Army Analysis (discussed in the next section).

"Force sizing" is an integral part of this process which allocates limited resources in accordance with guidance and is the ultimate basis for manpower distribution and force structure. Figure 4-1 reflects six levels of forces. The evolution of the force results from a sequence of actions which progressively refines initial estimates. Beginning with minimum-risk force requirements and progressing to the current force, an increasingly detailed definition of the force structure and an increasingly restrictive resource guidance is developed. These various force levels become the basis for force level analyses that define force structure.

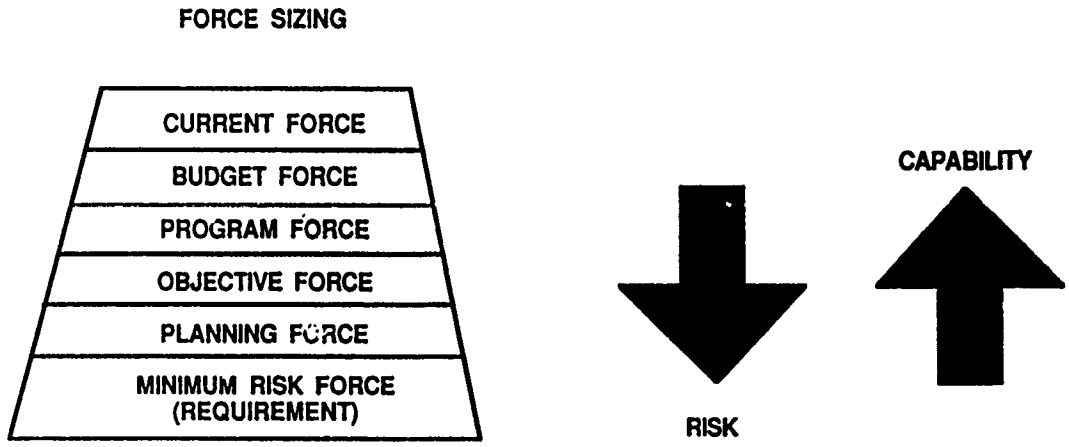


Figure 4-1. Six Levels of Forces

4.2.3 Force Level Analyses

The Army force development process starts with the Concept Based Requirement System (CBRS). The CBRS is a system by which concepts are developed and analyzed and from which doctrinal, training, organizational, and materiel needs of the Army evolve. These concepts become inputs into the Mission Area Analysis (MAA) process, an extensive assessment of force capability within battlefield or functional areas. In the MAA the Army establishes its warfighting needs based on the "Program Force." The capability of the Program Force to defeat the projected threat is analyzed using wargames or models. Deficiencies are identified and corrective action recommended. At this point, the analysis should be constrained by manpower ceilings, funding, personnel considerations (such as aptitude requirements), training limitations, etc. The deficiencies and solutions are prioritized in the Battlefield Development Plan (BDP) and Mission Area Development Plan (MADP), which become the basis for converting proposed solutions into specific programs and supports TRADOC input into PPBES.

The "Program Force" used in the MAA is developed during the Total Army Analysis (TAA) process. The Army Plan (TAP) is the basis for Army guidance and the "Objective Force" is analyzed using the TAP. The Program Force--both resourced and unresourced--is developed and included in the POM. The product of the TAA and POM processes is the approved force structure for the Total Army--Active Army (COMPO 1), National Guard (COMPO 2), Army Reserves (COMPO 3), and unresourced (COMPO 4). COMPO 1 through 3 become the bases for the "Budget Force." ("COMPO" refers to component.)

In addition to the top down approach used by TAA to determine force structure, the components of the force are analyzed using Functional Area Assessments (FAA). The FAA focuses on the total demands placed on an MOS and the ability to satisfy the demands. The TRADOC School or Center with proponency for the MOS is responsible for the FAA.

This is important to MANPRINT because these force level analyses are the basis for manpower constraints. As can be seen, the force structure (and supporting resources) are systematically determined through a series of analyses. Consistency between analyses is essential and is gained by using common parameters such as the Program Force. These analyses in turn provide the basis for MANPRINT guidance on manpower and force structure. In addition, the planning factors (as noted in 4.2.1) used in developing these analyses should be used in subsequent analyses as appropriate.

4.2.4 System Analysis

Current system analyses address engineering analyses; engineering performance capabilities; and operational performance and force design capability. Engineering analyses include item system models--components of a system--and environmental models. For example the Army Materiel System Analysis Activity (AMSAA) has models on hardware performance of components and the Ballistics Research Lab has a vulnerability model for predicting penetration of armor plate. The NATO mobility model is used for predicting mobility of equipment based on engineering characteristics. Many of the TRADOC schools and centers have simulations for determining equipment performance and operational effectiveness. Finally, the MAA uses combined arms simulations to determine force effectiveness. In addition to the hardware oriented analyses, soldier-oriented assessments--such as workload and training analyses--need to be conducted.

Historically, as reflected by each of the ellipses in Figure 4-2, these analyses have been conducted independently and not integrated or linked together. If the system is to be viewed as a whole, these analyses need to be linked and sensitive to all system variables. An integrated system necessitates some degrees of analytical commonality. In addition to linkage, consistent input variables -- such as usage rates -- should be used. Finally, and particularly

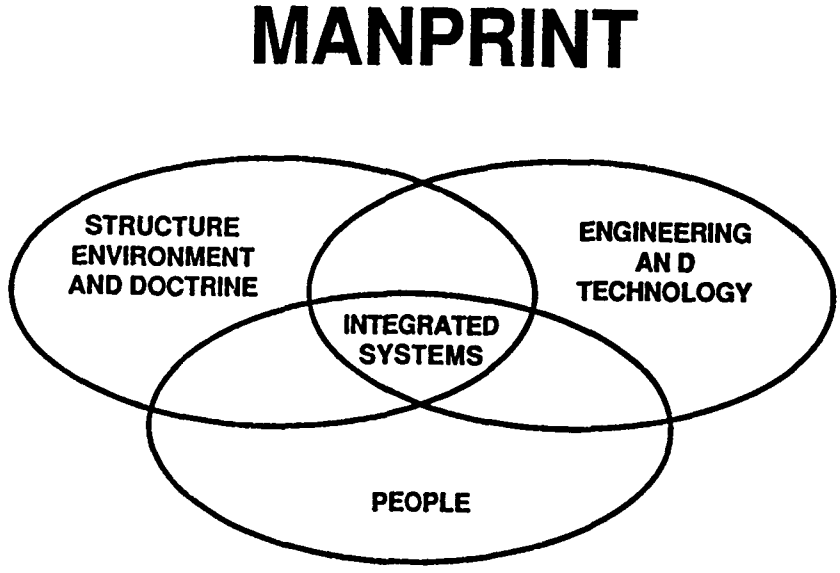


Figure 4-2. Integration of MANPRINT Variables

important from a MANPRINT perspective, soldier characteristics and performance must be considered in determining force effectiveness.

4.2.5 Effectiveness Analysis

In the Training and Doctrine Command, analysts have distinguished operational effectiveness from performance. "Operational effectiveness is a force attribute; performance is an attribute of a particular system." (TRADOC Pam 11-8.) Then Pam goes on to point out that a "new system may accomplish its assigned task far better than some alternative, but its operational effectiveness may not be significantly greater than the alternative because its introduction into the force does not produce a significant improvement in the force."

Historically, the contribution of human performance and reliability to system performance was not quantified. In the materiel acquisition process, the focus was on the performance characteristics of the hardware despite the writings in the AMC Engineering Design Handbook, AMC Pam 706-102, which emphasizes human performance and reliability. These performance characteristics were usually provided by the combat developer, were calculated within the materiel community, and represented system performance against passive targets. The contribution of the soldier to operational effectiveness or total systems performance could only be inferred, since the estimates did not describe the interaction of groups, types of weapons, and

soldiers that actually occurs on the battlefield. Field tests were then used to estimate operational effectiveness. Today total system performance can be evaluated quantitatively by established measures of effectiveness. The effect of qualitative variables such as leadership, soldier performance, and morale can also be assessed.

To accomplish MANPRINT, Army combat developers, trainers, acquisition specialists, testers and evaluators, logisticians, laboratory scientists and engineers must apply the appropriate analytical techniques to predict, understand, and control the relationship between force structure, soldiers, and technology. These analytical techniques can be classified in a number of ways, but it may be most helpful to relate MANPRINT analytical techniques to the hierarchy of effectiveness measures described in TRADOC Pam 11-8 (as shown in Figure 4-3).

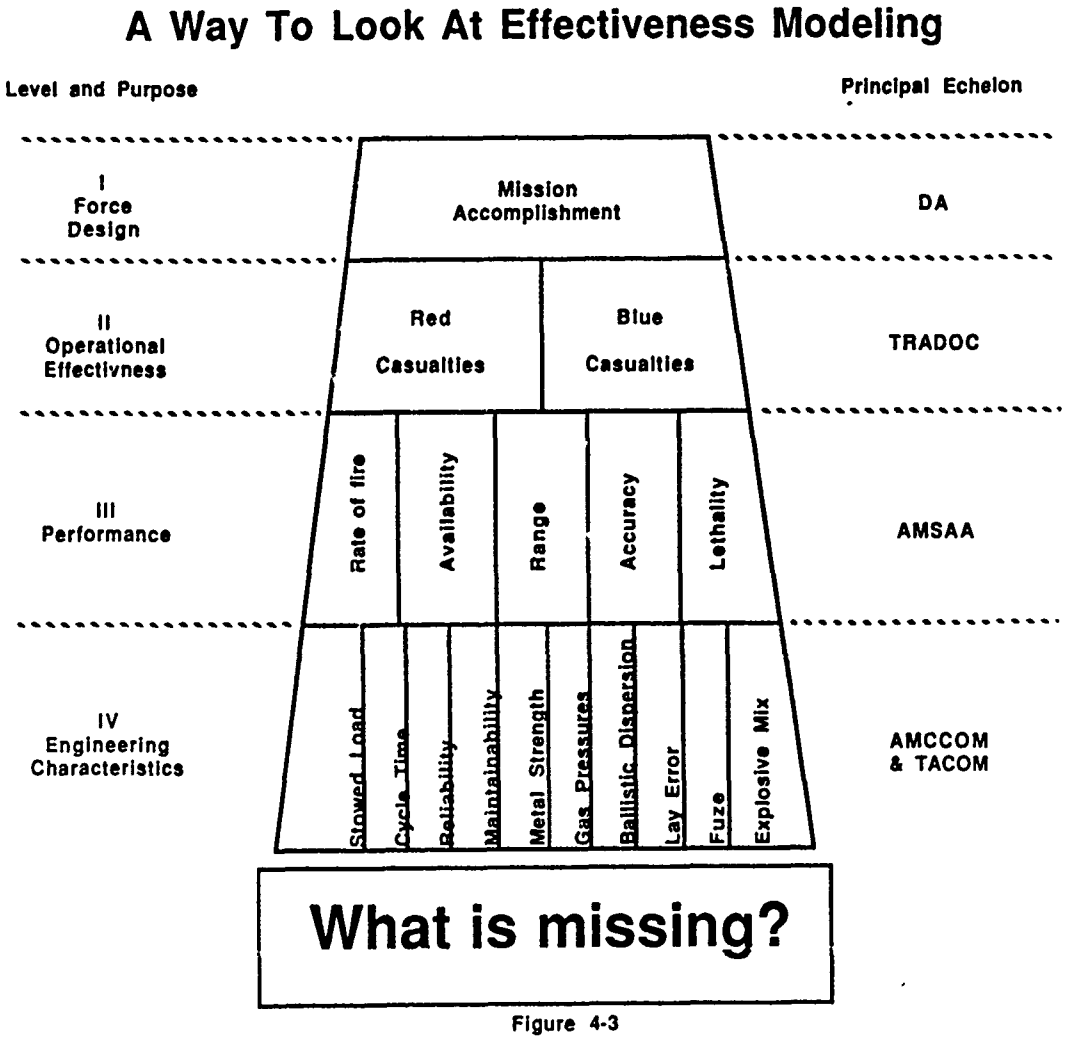


Figure 4-3

Figure 4-3. A Way to Look at Effectiveness Modeling

As shown in the figure, there are multiple levels of measures of performance and effectiveness; a variety of analytical techniques are used for acquiring those measures. Measures at one level are dependent upon one or more measures at a lower level. The figure shows information that could be used in selecting the best artillery system. The materiel acquisition system has traditionally focused on engineering characteristics (level IV) and hardware performance (level III). MANPRINT requires consideration of soldier as well as engineering characteristics and performance at all levels. For the model to work, soldier performance must be integrated into the modeling.

4.3 MANPRINT PLANNING FACTORS

Just as general planning factors--such as usage rates and equipment densities--must be defined early and used consistently, planning factors within each MANPRINT domain must also be defined and consistently used in making assessments.

The MANPRINT assessment will normally compare the new system with its predecessor in terms of performance and supportability. Agreement must be reached on the basis for comparison. For example, will manpower requirements be compared to the base table of organization and equipment (TO&E) or a modified TO&E (MTO&E)? If the MTO&E is used, should the basis of comparison be required strength--which relates to the program force and readiness--or authorized strength--which relates to the budget force and congressional pay appropriations? In considering system/organizational resiliency and operational effectiveness should operating strength and degraded strength be considered? Are common qualitative personnel factors being used? Have a realistic training strategy and concept been developed? If so, what are the key factors concerning training resources? What are the parameters for acceptable residual hazards? Consistent MANPRINT planning factors need to be used for all analysis to enhance consistency of results.

For more information on the domains and their interrelationship, see Appendix G.

4.4 MANPRINT PROCESS -- TECHNICAL REQUIREMENT

4.4.1 Information Needs and Availability--Estimate of the Situation

The MANPRINT process, as captured in the System MANPRINT Management Plan (SMMP), serves as the basis for identifying information needs and availability. The description (paragraph 2) identifies:

- o system capabilities to include human performance requirements
- o selected acquisition strategy

- involved agencies
- past guidance and decisions

System capabilities serve as the basis for developing MANPRINT Concerns (paragraph 4) and Questions to be Resolved (Tab D). This becomes the information need which will be further developed as the system evolves. In addition, the acquisition strategy defines the parameters within which the MANPRINT technical effort must plan to operate. The involved agencies provide a listing of all organizations who will provide support and comment to the MANPRINT effort. Finally, the past guidance and decisions should contain goals, constraints and planning factor information to ensure a coordinated and consistent technical effort.

MANPRINT objectives (paragraph 3a) will add to the information needed by establishing requirements which must be researched and analyzed. For example, if a goal is to eliminate "High Driver" tasks, then an analysis, such as an Early Comparability Analysis, must be conducted to identify "High Driver" tasks.

In Data Sources/Availability (paragraph 3b) and Tab A (Data Sources) sources of available information to satisfy the need will be identified. The "remaining" information needs then become the basis for planning the analysis effort.

4.4.2 Planning the Analysis Effort

Information that is most critical to ensuring MANPRINT requirements are identified and integrated into the design process has the highest priority and must be supported with available resources. Failure to develop essential MANPRINT information carries a high risk that performance, supportability and cost objectives will not be met. Information needs that have a minor impact on MANPRINT objectives should have a lower priority because failure to develop that information is less risky. The risk assessment should be recorded in paragraph 3b and serves as the basis for both minimizing risks and using technical management resources for high priority analyses.

The analysis effort will be constrained based on manpower, dollars, and time. All planned analyses are listed in Tab C (Task Description) along with the rationale/justification and resource requirement. It is essential that the resource requirements for each task be identified and a demand placed on the resource system if a task cannot be performed with existing resources--dollars and manpower. The high risk analysis should receive resource priority.

Time may also constrain the analysis effort, especially if an accelerated acquisition strategy is chosen. In Tab B (MANPRINT Milestones Schedule) the planned analysis effort is plotted within the key acquisition parameters. This schedule

and the resources required to accomplish the tasks provide an "activity profile" of the level of effort required to conduct the planned analysis effort. An analysis of this "profile" may reveal that rescheduling high and low activity periods--smoothing peaks and valleys--will actually permit more to be accomplished.

This is an iterative process as reflected in Figure 4-4.

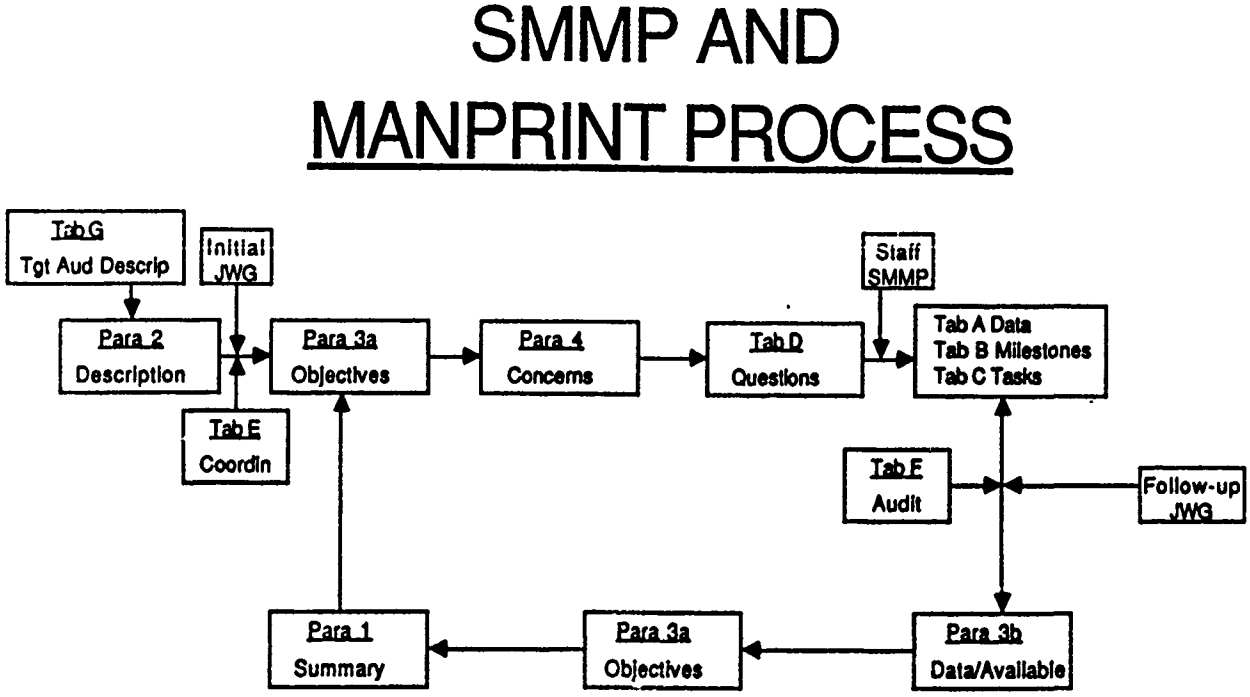


Figure 4-4. SMMP and MANPRINT Process

4.5 SELECTING TECHNIQUES

4.5.1 Purpose

Selective analytical techniques are used throughout the materiel design and development process. They are used by combat developers, training developers, materiel developers and industry. Prior to program initiation, the Army uses various techniques to derive the MANPRINT goals and constraints for input into O&O Plan/MNS, SMMP and ultimately system requirements.

During system design, industry uses techniques as required by the contract or self-initiated to arrive at design decisions that respond to MANPRINT goals, concerns and questions--information needs. The analytical techniques provide the tools to answer questions that are raised in connection with trade-

offs of design alternatives, in evaluating optimization options and in determining compliance with contract requirements.

Finally, techniques will be used by the Army or industry to validate design compliance. As Figure 4-5 indicates the TRADOC starts the process; all players, however, need to interact throughout the process.

Use of Analytical Techniques

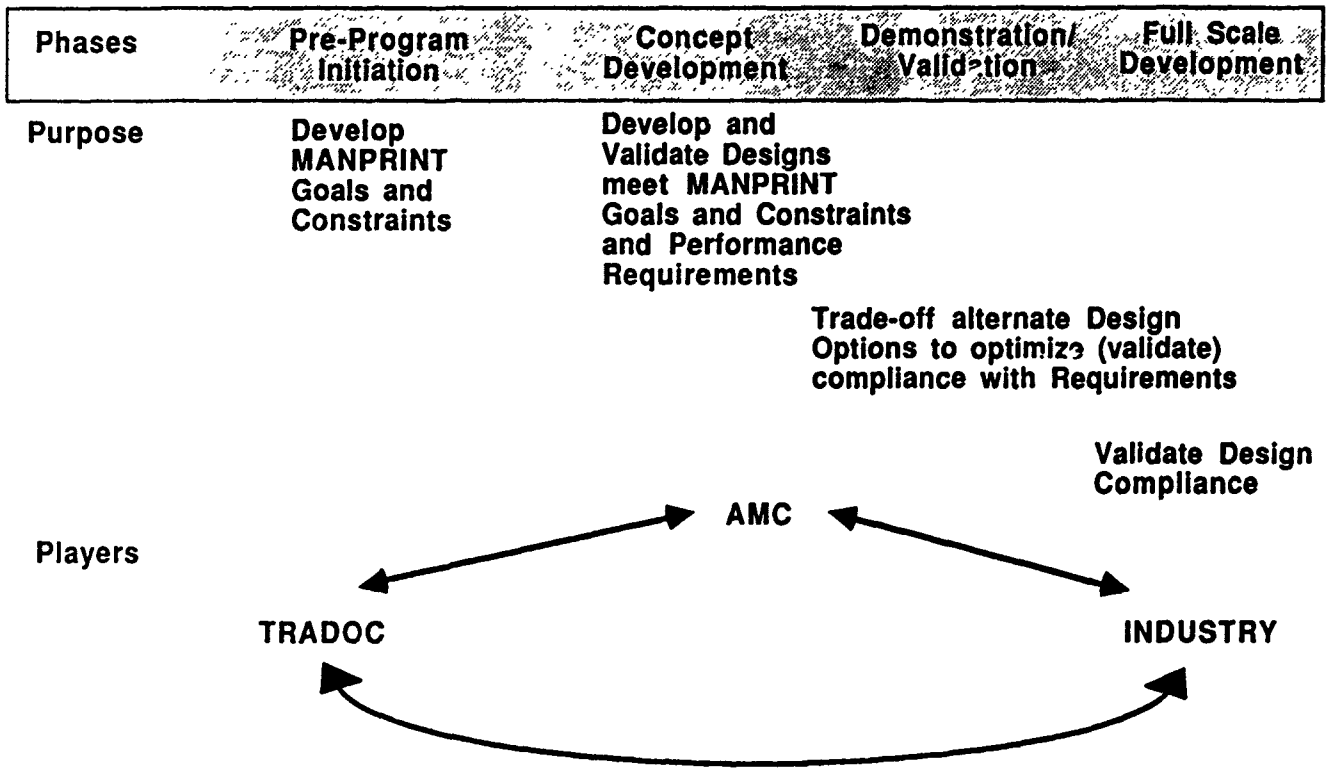


Figure 4-5. Use of Analytical Techniques

4.5.2 Systematic Approach

The MANPRINT ellipses shown earlier in Figure 4-2 can be used as a mnemonic to cue the analyst to the categories of analyses that may be required. This figure represents the interaction that takes place among force structure, environment, and doctrinal decisions; engineering and

technology decisions; and manpower, personnel and training decisions.

Many things are known at the time a decision is made to meet a battlefield deficiency with a materiel solution. These include knowledge of the threat, missions, scenarios, operational concepts (doctrine), and predecessor systems (if there is one). Two of these areas--doctrine and engineering--are critical because they affect the demand for skilled manpower. Although the engineering may not have been done yet, a lot can be gained from our knowledge of the predecessor system.

This knowledge about the system to be replaced may be categorized as knowledge required to:

- Improve an existing system (Howitzer Improvement Program)
- Replace the predecessor system with a new system that is significantly different (Bradley)
- Acquire an entirely new capability (Multiple Launch Rocket System).

Each of the above will have significantly different impacts on capability, organizational structure, doctrine personnel, and training. The more of these areas that are affected, the more complex the problem becomes.

An understanding of the predecessor system gives some insight into the degree of complexity involved in bringing a new system into the inventory. For example, the acquisition of a new bayonet does not have the same implications for force structure as does the introduction of a Multiple Launch Rocket System unit. Each area must be explored for MANPRINT implications. With this understanding, the analyst can draw some inferences about the nature of the analysis required, depending on the type of equipment, e.g., individual clothing, crew-served weapons, vehicles, and trailers.

Based on the above discussion an analyst can construct a matrix by which to check the thoroughness of the planning process. This matrix may resemble the example in Figure 4-6. The MANPRINT analysts must keep in mind that their job is to identify the functions that affect humans. As this is done, performance standards and measures will have to be addressed and design goals and constraints will emerge.

PLANNING MATRIX

FUNCTION	FORCE STRUCTURE	DOCTRINE	ENVIRONMENT	ENGINEERING	TECHNOLOGY	EXTERNAL FACTORS	REMARKS*
MANPOWER							
PERSONNEL							
TRAINING							
HFE							
HEALTH HAZ							
SYSTEM SAFETY							

* for other factors such as performance, cost, associated items of support equipment

Figure 4-6. Planning Matrix

The process is one of defining the problem and attempting to categorize what we know in order to communicate to others. Generally, when it is critical that we have information and we can't obtain it, we make assumptions. These assumptions should be based on previously agreed to planning factors.

As the matrix begins to take shape, interrelationships must be identified to determine potential tradeoffs. These interrelation-ships are key to identifying the range of options. The analyst must ask a series of questions to probe these interrelationships in order to establish goals and constraints. Some questions that might be asked are:

- What tasks performed by the soldier are critical to system performance?

- How is human performance affected by cognitive workload?
- How will systems performance be affected by changes in manning levels?
- Is there any aspect of the equipment and its use that could degrade soldier performance, e.g., ride quality?

Each of these questions may be followed up in greater detail. For instance, assuming that cognitive workload is high and may affect performance, the question is how to reduce it to acceptable levels. If training is offered as the answer, then a series of questions like these should follow:

- What evidence is there that training will reduce workload?
- How much initial and sustainment training is required?
- Are there sufficient resources (time, dollars, and people) to execute the training?
- What effect do individual skill differences have on workload, training, or both?
- If individual differences make a difference, then what are the implications for personnel selections and distribution?

As industry prepares to respond to the Army's requirements, they too must identify interrelationships, tradeoffs, and strategies. The MANPRINT community within industry should quantify answers to these questions as much as possible to facilitate communications within the company. They will be expected to explain what to measure, and what the validity of the measure is. Going back to the training and workload example, the follcwing questions should be answered:

- How should we measure workload?
- What constitutes being overworked?
- What are the design guides and specifications?
- How do we analyze and predict workload?
- How do we test to determine if we are within variance?

4.5.3 Types of MANPRINT Techniques

4.5.3.1 Manpower, Personnel, and Training Analyses

MANPRINT calls for an expanded focus, a focus which encompasses the man-machine interface but also addressed the total system-work force interface and environment. This calls for the use of new analytical tools and techniques. In the following paragraphs we describe some of the advanced tools and data base management techniques now available to influence and evaluate the design process, as well as the more traditional human factors methodologies which include simulation, modeling, functional task analysis and others.

MANPRINT techniques serve two major functions. First, they present human resource data or parameters to design engineers in a manner and format that can be used to influence the design of complex hardware and software systems. Second, the techniques evaluate the impact of system designs on human resource constraints. In the second function the techniques discriminate between design alternatives (Does design alternative A have less impact than alternative B?) as well as evaluate designs against a given standard (Does a particular design meet its MANPRINT goals and constraints?).

MANPRINT techniques fall into two classes (see Figure 4-7).

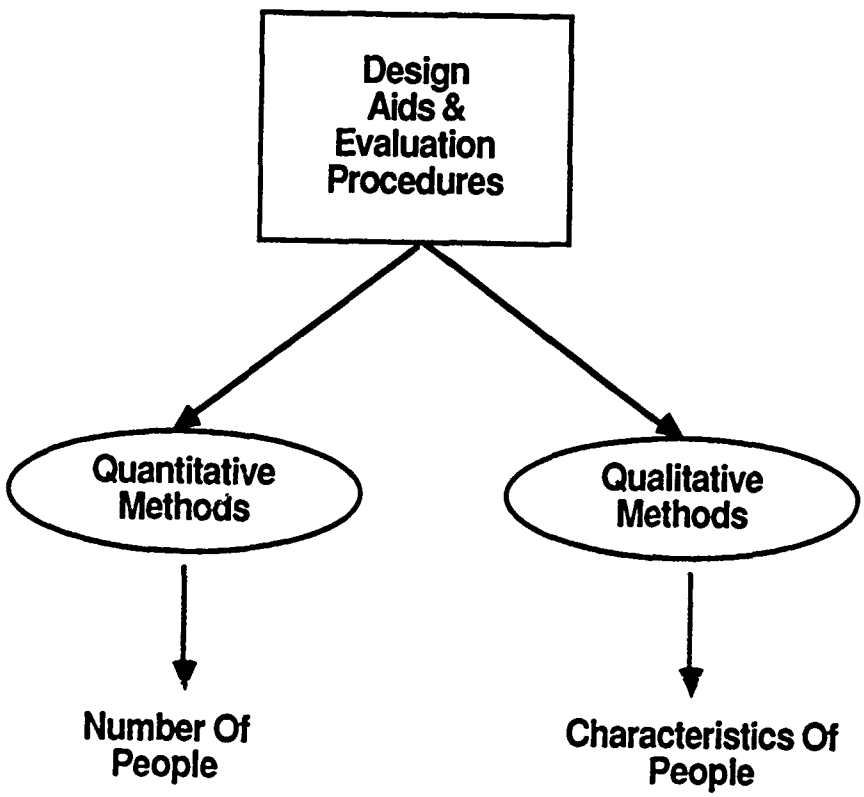


Figure 4-7. Design Aids and Evaluation Process

Quantitative techniques address the number of different human resource requirements that will be needed to operate, maintain, and support a system when it becomes operational. Output from such techniques is usually expressed in requirements for so many personnel within a given job or so many training slots within a given year. Qualitative techniques address the skills and abilities the personnel will need to perform that job or succeed in the training. Output from these techniques are expressed in terms of psychological characteristics like cognitive or physical abilities. MANPRINT programs currently tend to conduct quantitative and qualitative analyses independently and they will be discussed that way in the following sections. However, the two sorts of procedures can be viewed as interrelated, and the development of new models or techniques which capture this relationship constitutes an important challenge to MANPRINT analysts.

4.5.3.1.1 Quantitative Techniques

Most of the MANPRINT quantitative procedures are based upon some form of comparability analysis. Within a comparability analysis, existing, similar systems are analyzed to determine which components they share with the system design under evaluation. Human resource data from these systems become input to a number of computational algorithms in order to infer the manpower, personnel and training (MPT) implications of the new design. The best known of the quantitative techniques are HARDMAN (Hardware vs. Manpower) and ECA (Early Comparability Analyses).

Quantitative techniques like HARDMAN or ECA can be applied early in the development of a system in order to influence its design. This influence is typically manifest in the identification of existing system components or subsystems which if repeated in the new system could lead to excessive MPT requirements when it becomes operational. Quantitative procedures can also be used as design evaluation tools by permitting comparisons between the estimated MPT requirements of the alternative design configurations and those of the existing system or systems that it is meant to replace or supplement in order to determine the best technical approach from an MPT perspective.

4.5.3.1.2 Qualitative Techniques

The development of procedures to address the qualitative (personnel skills and abilities) aspects of a MANPRINT analysis initially lagged behind that of quantitative methods. The slow start for qualitative techniques was most likely attributable to the fact that relationships of human ability to task and job performance are not well defined. Yet it is in the area of addressing qualitative requirements that MANPRINT has received much of its initial impetus. A key concern of MANPRINT has always been that today's sophisticated hardware and software systems may be too complex for the average soldier.

At the present time the Army has not endorsed any specific techniques or models to address this very important area. However, there is research ongoing and some numbers of industries have developed interesting approaches.

4.5.3.1.3 Training Analyses

Training analyses must evaluate four interrelated areas--task learning difficulty, performance difficulty, decay rate, and available training resources. An ECA will identify problem tasks, the nature of the problem and recommend a solution. The individual solution may require more soldiers, brighter soldiers, more or different training, or a design change. In addition to individual tasks, all soldier tasks must be evaluated to assess soldiers workload and available training resources. This is essentially a supply-demand assessment. The demands in terms of time, supplies, devices and facilities must be assessed against available resources. For example, the Army Reserve and National Guard have a limited number of training days per year (37 and 38 days respectively); if the training requirement exceeds available days, then their training readiness will suffer. How many training days does an active Army unit have after subtracting time for exercises, ARTEP's, maintenance, and local command requirements? Will the sustainment training requirement fit in the available training box? If not what are the alternatives if training readiness is to be maintained?

4.5.3.2 Other Types of Analyses

The following references describe other types of analyses that may be used during the design and development process:

- Human Factors Engineering Analyses (MIL-H-36855B)
- Safety and Health Hazard Analyses (MIL-STD-882)
- Logistic Support Analysis (MIL-STD-1388 and AMC Pam 700-4, LSA Techniques Guide)
- Behavioral Analyses (David Meister, Behavioral Analysis and Measurement Tools, New York: John Wiley & Sons, 1985).

In conducting any of these analyses, the basis for consistency is the use of agreed upon planning factors. For example, MANPRINT planning factors and objectives must be entered on LSA Data Record A, Operation and Maintenance Requirements, to ensure manpower and skill constraints are considered. Figure 4-8 indicates the types of analyses that may support the design process.

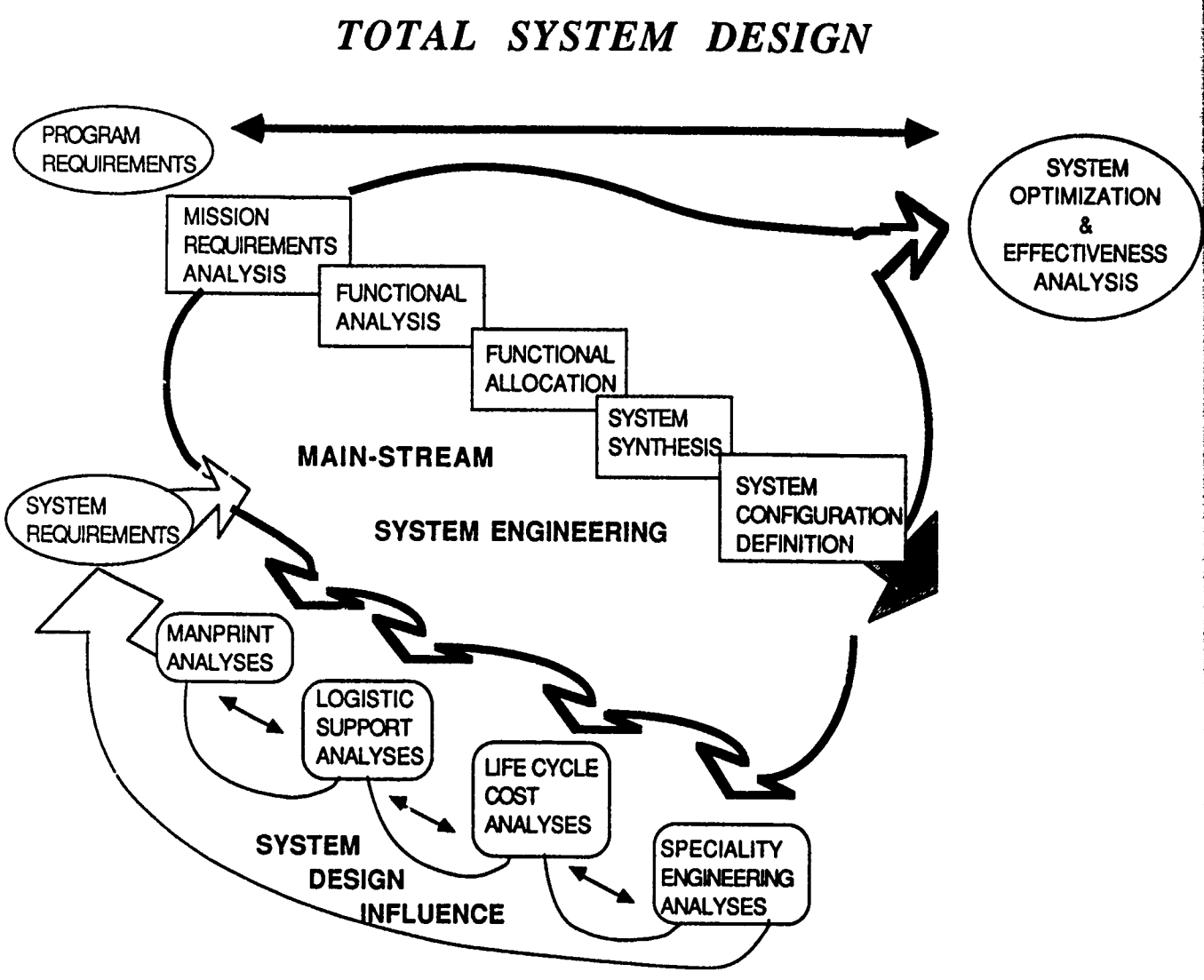


Figure 4-8. Total System Design

4.5.5 Planning for Analysis by Industry

Industry would follow a process similar to that used by the Army in developing their analysis plan and selecting techniques. Their technical approach should be documented in a management plan similar to the SMMP. The major difference is the purpose; industry performs analysis required by the contract on the Contract Data Deliverable List (CDRL) and those analyses necessary to aid in the design process. Effective analyses requires good government furnished information such as Target Audience Descriptions and MANPRINT goals and constraints. Industry has the capability of performing many of the analyses already discussed such as HFE, hazard and LSA

analyses but may need to develop techniques or get assistance for manpower, personnel or training analyses.

4.6 RETURN ON INVESTMENT

4.6.1 MANPRINT Cost Analysis

4.6.1.1 General

MANPRINT may result in higher acquisition costs. Higher acquisition costs are acceptable provided that the additional investment will be amortized in a reasonable period of time through lower operating and support costs. MANPRINT's cost focus is on operating and support (O&S) cost, which may be lower because of reduced manpower, personnel and training requirements. In addition, cost and benefits resulting from improved system performance must be evaluated. Accurately identifying the total cost requires the combat and materiel developer to properly define the total system--all the people and equipment necessary to field and sustain a weapon system.

Life cycle costing is a planning and management technique to identify all resources expended on a system from research and development to the end of the life cycle. By focusing on life cycle cost, the total cost of ownership becomes explicit rather than the limited focus obtained by concentrating solely on production or acquisition costs. Approximately 50% of life cycle costs are O&S costs; approximately 50% of O&S costs are invested in manpower, personnel and training. Consequently, the additional cost of MANPRINT-driven design changes--either to improve performance by eliminating high drivers or to reduce support demands by lowering manpower, personnel or training requirements--may be more than offset by O&S cost savings.

4.6.1.2 Cost Analysis Responsibilities

The MANPRINT Coordinators should understand that there is no single organization for cost analysis, all echelons concerned with studies and analysis from DOD to the proponent schools and centers have cost analysis elements. From a system development standpoint it is important to understand that AMC is the developer of cost estimates for AMC and TRADOC. The Chief of Cost Analysis, HQ AMC exercises staff supervision over AMC's field activities, assures the validity of AMC cost inputs and provides the interface between AMC and TRADOC. All major AMC agencies have costing elements. In conducting cost analysis, TRADOC obtains the cost estimate from AMC. Within HQ TRADOC, the Cost Analysis Branch, Studies and Analysis Directorate, Office of the Deputy Chief of Staff for Combat Developments is the focal point for materiel system and force structure costs. The TRADOC Analysis Center (TRAC) is the analytical agency of TRADOC and does much of the TRADOC cost work. At the proponent school level, the Concepts and Studies Division with the Combat Development Directorate is responsible for cost analysis. Figure 4-9 provides a broad view of the DOD/Army costing organization. Each MANPRINT coordinator

should specifically establish a relationship with and understand the costing framework within his/her own organization so that MANPRINT cost may be identified and used in the requisite tradeoff decisions and in milestone decisions.

COST: Organization For Costing

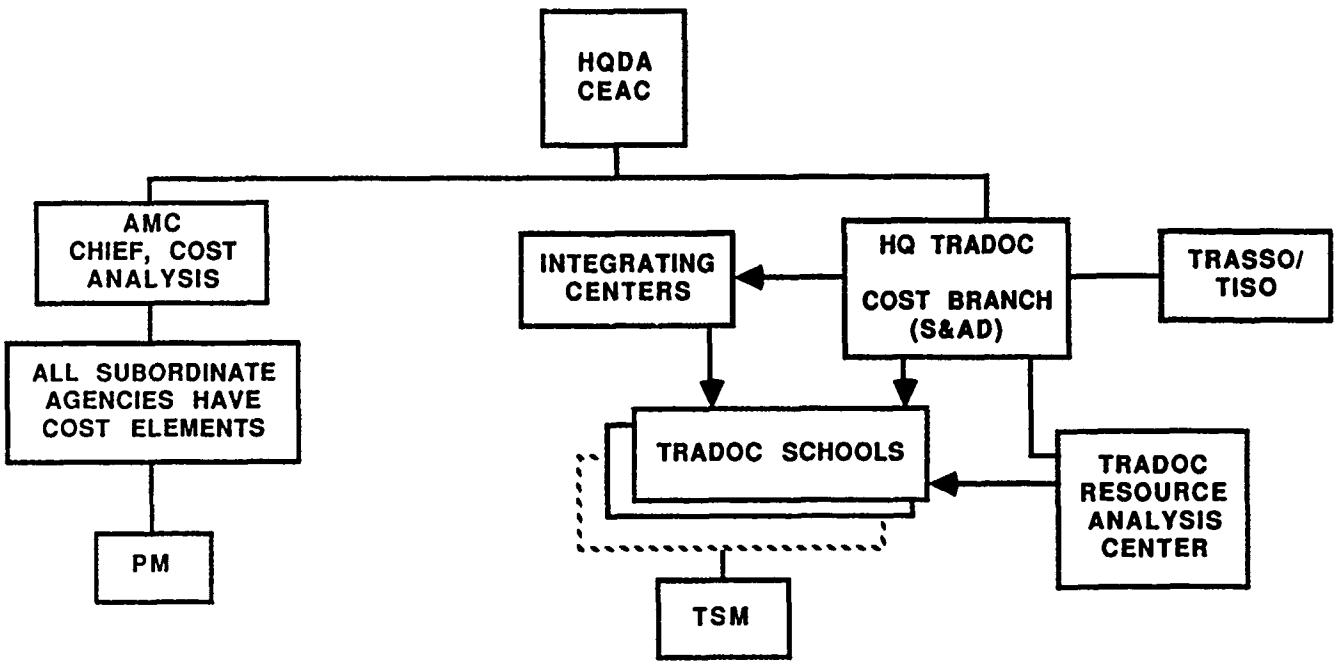


Figure 4-9. Organization For Costing

4.6.1.3 Cost Estimates

The basic cost document by which costs are controlled, budget requests developed and cost analysis performed is the Baseline Cost Estimate (BCE). The BCE is prepared by the program manager and required at milestones I, II and III. It is updated annually and serves as the basis for Program Development Increment Packages (PDIP) to fund the program. In addition, an Independent Cost Estimate (ICE, is developed by a joint cost team or the Army's Cost and Economic Analysis Center (CEAC) for major programs in order to evaluate their BCE's and determine the Army Cost Position on those programs. The ICE statistically derives cost--a top-down approach; the BCE aggregates the cost of the total system--a bottom-up approach. The other key cost document is the Cost and Operational Effectiveness Analysis (COEA), the cost portion of which is

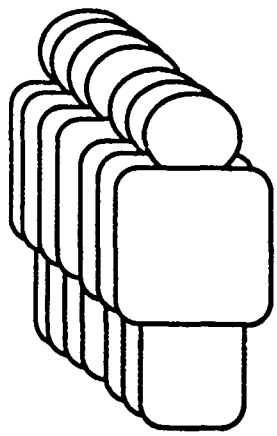
based on the BCE. Consistency between cost estimates is essential. This can be accomplished by using the same soldier cost factors--referenced in the SMMP--throughout.

MANPRINT costs may be encountered throughout the materiel system costs. For example, Design to Production Cost includes engineering costs which may be heavily influenced by human factors engineering, system safety and health hazards design criteria. Weapon System Cost includes training costs - new equipment training and training devices, but not institutional or sustainment training. Finally, Total Life Cycle Cost include O&S costs. MANPRINT staff officers, working with the MJWG, must recognize where the MANPRINT costs are in the overall cost structure to identify cost tradeoffs between MANPRINT-driven engineering design costs and O&S costs. In performing comparative cost analyses, the predecessor system will normally be used to estimate cost savings.

In conducting the cost analysis, soldier costs must be clearly identified. As shown in Figure 4-10 many variables must be taken into consideration ranging from pay and allowances to benefits. These will also vary by MOS and grade.

COST OF A SOLDIER

Soldier costs are:



- **Basic Pay**
- **Selective reenlistment bonus**
- **variable housing allowance**
- **overseas pay allowance**
- **BAS and BAQ, Clothing**
- **Benefits**
- **Accession**
- **Training**
- **PCS**
- **Separation**
- **VEAP**
- **Retirement**

Cost data is obtained from

Pay/Allowance - COA - (USAFAC / CEAC)

Training - TRADOC (DCSTD)

Figure 4-10. Cost of a Soldier

A significant cost driver that varies between MOSs is length -- and expense -- of institutional training. When assessing the total soldier costs, all soldiers that affect the system must be considered - operator/crew, maintainers and supporters. The total soldier costs should be captured in the BCE. An example of the type of MANPRINT O&S costs are reflected in Figure 4-11. The BCE should be critically reviewed to identify and comprehend all of the MANPRINT costs. It is a prime document for use in MANPRINT cost analysis.

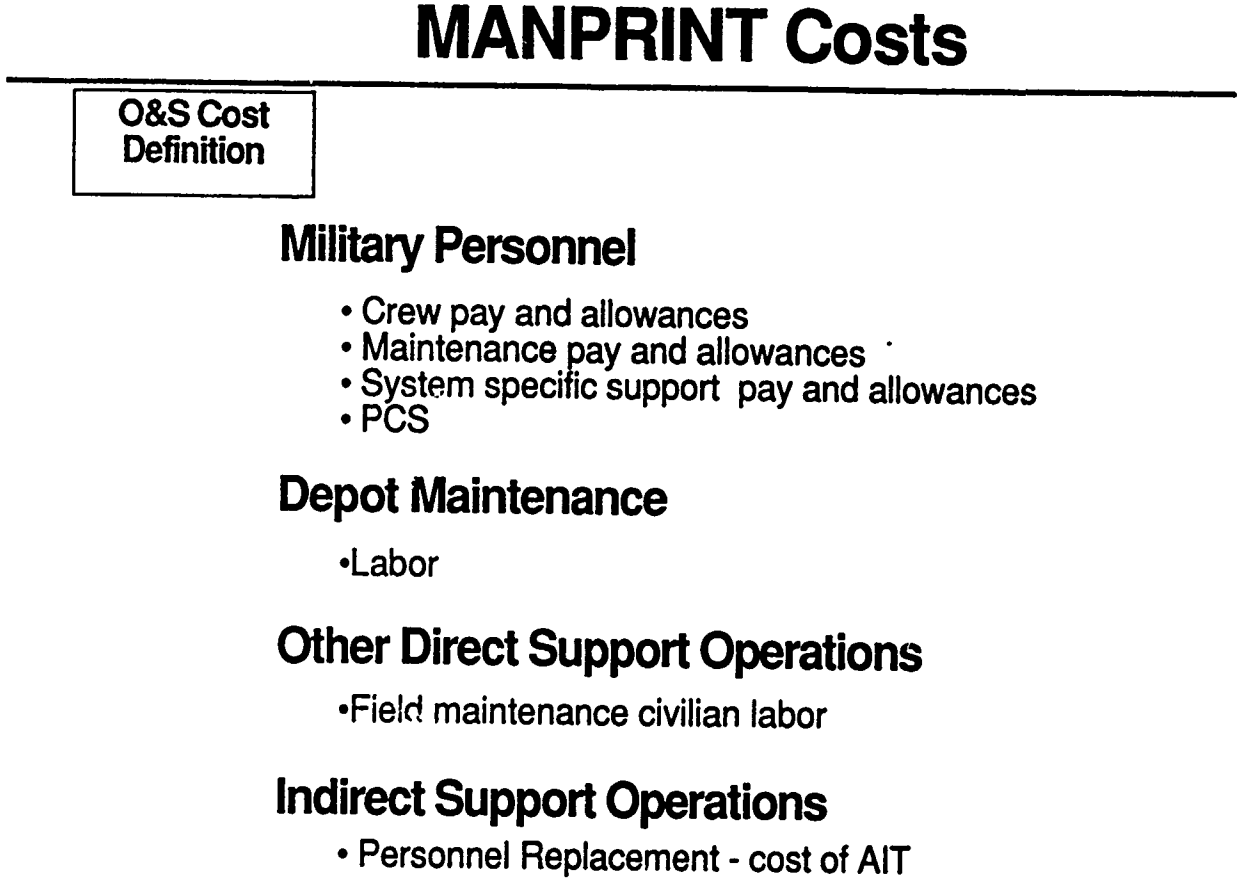


Figure 4-11. MANPRINT Costs

4.6.1.4 Cost Analysis

Using the BCE, cost analysis is performed to evaluate resource implications, performance and effectiveness. If two or more systems have comparable performance, significantly different costs may be the tie-breaker. Cost must also be evaluated in relationship to different levels of system performance and operational effectiveness. "MANPRINTING" design may justify increased cost based on improved system--including soldier--performance.

The most important analysis is the Cost and Operational Effectiveness Analysis (COEA). Ultimately, cost will be tied to operational effectiveness. The BCE is the basis for the cost portion of COEA. TRADOC performs the operational effectiveness analysis and is responsible for preparing the COEA. COEAs are prepared for major systems to support milestone I and II decisions; mini-COEA's are prepared for non-major systems. The purpose is to determine the cost ranking of alternative designs to support the design decision. In deciding on competing systems, the cost ranking is coequal with operational effectiveness ranking. MANPRINT is a major COEA consideration. As discussed, capturing total system MANPRINT cost is a key concern in developing the BCE. In performing the various effectiveness analyses--system performance or operational effectiveness analyses--human performance or "man in the loop" must be considered.

Contingency cost analysis should also be done and address the issue of not making a complete buy. At some point in a reduced buy, there are no savings, and the manpower, personnel, and training cost cannot be supported. This results from the loss of commonality and standardization that would be achieved if a complete buy were made and the displaced equipment was phased out of the inventory. Going beyond that point degrades readiness, and significantly confounds the manning and training mobilization issues. The total buy analysis must also consider the manpower implications of the basing plan. This includes the military and civilian manpower (contract supported or government) that will be required at the post, camp, depot, or station to provide the needed support to soldiers and families.

4.6.2 Force Capability and Readiness

Force capability and readiness is enhanced by capitalizing on technology. Technological potential can only be realized by ensuring compatibility between equipment, force structure, environment, doctrine and soldiers--in short an integrated system (Figure 4-12).

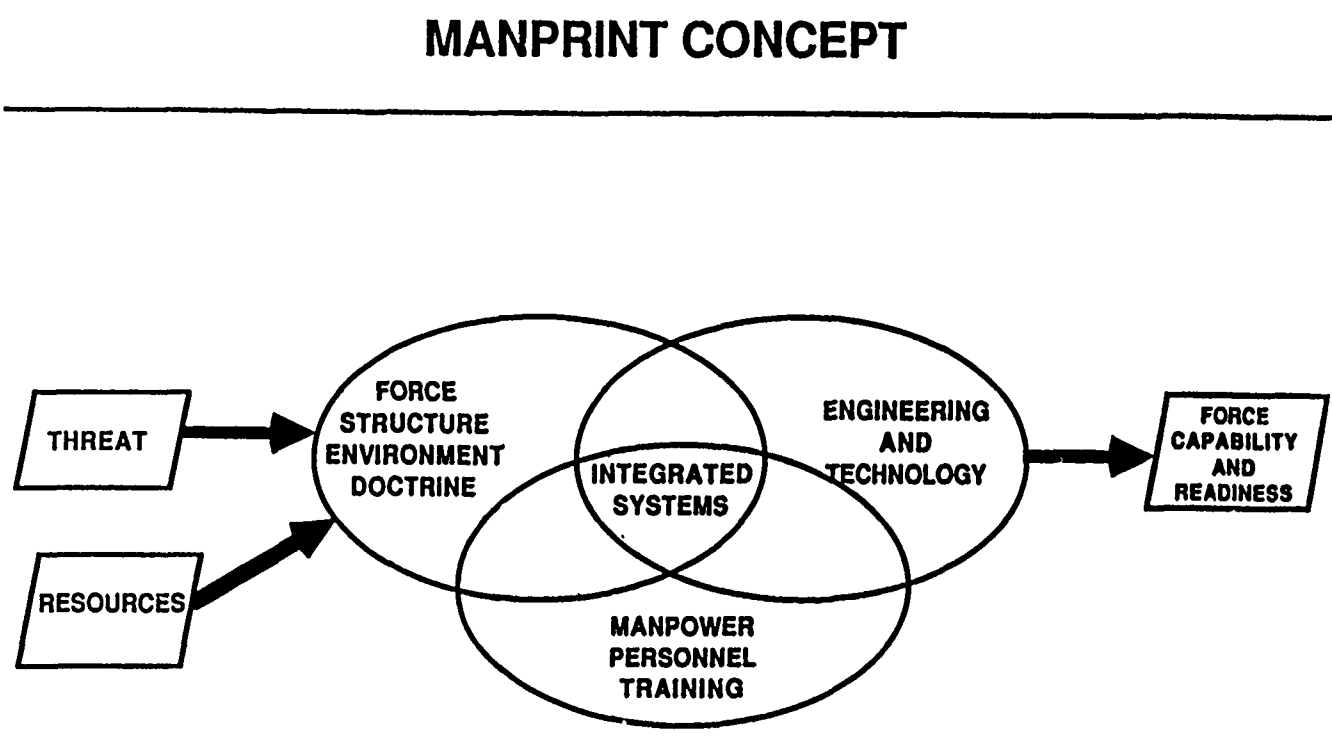


Figure 4-12. Force Capability and Readiness (Ellipses)

As shown in Figure 4-13 the MANPRINT technical effort is focused on contributing to force capability and readiness by addressing human performance in system performance and optimizing the match between soldiers and equipment--the focus of the technical effort. If this is accomplished then force effectiveness--a combination of force capability and readiness --will be achieved.

FORCE CAPABILITY AND READINESS

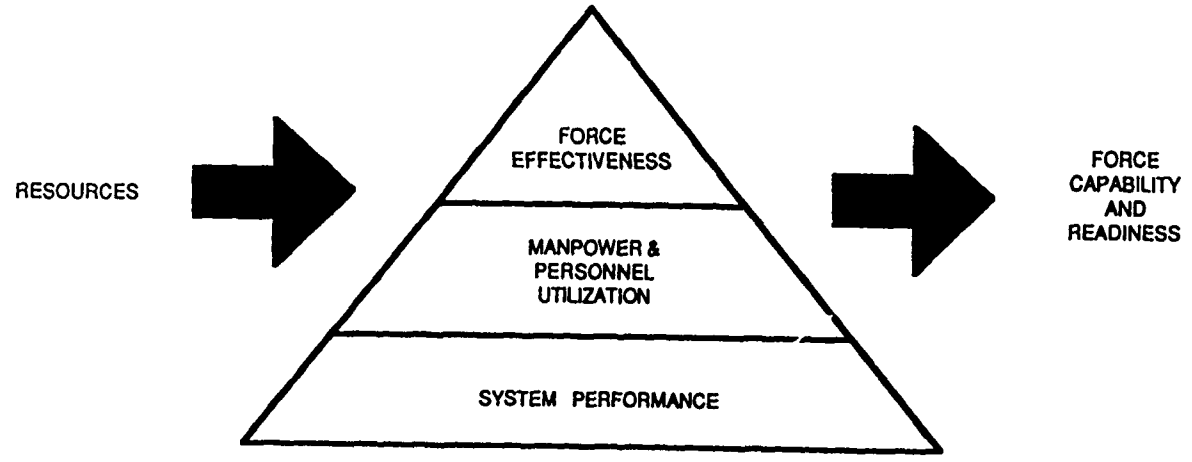


Figure 4-13. Force Capability and Readiness

Soldier performance and reliability are key ingredients of readiness. As defined in AR 220-1, Field Organizations: Unit Status Reporting, the components of unit readiness are manpower, equipment readiness, training and equipment on hand. MANPRINT is concerned with the first three.

From a manpower perspective, readiness is based on the Program Force or requirements. Since the Army's end strength is capped, the manpower component of readiness can be improved by reducing requirements for manpower--reducing the size of COMPO 4. Since this component bases the manpower rating on a comparison of required strength and operating strength, improvement in operating strength will also contribute to readiness, another area where MANPRINT can have a positive impact.

Equipment readiness is a function of reliability and maintainability. These two attributes are driven by equipment and soldier characteristics, matching equipment to the skills and abilities available in the target audience. Improvements made in this area should result in the equipment compensating for the soldier, resulting in reduced manpower, personnel, and training requirements. Moreover, this area touches the total system--operators, maintainers, repairers and supporters--with primary influence on the middle two.

Training status is based on ability to meet performance requirements. This is a function of the training requirement and resources available The training strategy and concept

address both these issues early in an attempt to ensure the training system acquired with the equipment is both effective and supportable.

The impact of considering the soldier during system design and development is far reaching. If done properly, system performance will be enhanced. Manpower, personnel, and training resources will be more effectively used; force capability will improve; and unit readiness will increase. The bottom line of MANPRINT is improved force effectiveness through leveraging technology with the soldier in mind. Remember the soldier--the return on investment will be high.

CHAPTER 5
FUTURE DIRECTIONS

5.1 INTRODUCTION

As detailed in the previous chapters the Army has developed and implemented a comprehensive Army-wide plan, procedures and controls to insure that manpower, personnel, training, human factors engineering, health hazard assessment, and system safety issues are integrated in the development and design of new weapon systems. The goals of this MANPRINT program are to improve:

- Total system performance. Total system performance is a function of equipment performance and people performance as they each are affected under varying environmental conditions, which include physical, social and operational conditions.

- Manpower and personnel utilization. All too often personnel requirements are dictated by materiel system design.

- Unit effectiveness. Unit effectiveness will be affected by goals. Improvement of total system performance and manpower and personnel utilization will enhance the ability of units to perform their mission.

The information contained in this primer is an attempt to share with both government and industry some of the areas viewed as critical to the program's successful implementation and use. This chapter briefly summarizes the need, the program, its status and future directions.

5.2 THE NEED

The explosion of modern technology holds the potential for greatly enhanced capabilities of military systems. Technologies such as artificial intelligence, robotics, directed energy weapons, millimeter/microwave integrated circuits and composite materials can lead to systems that have enhanced survivability, lethality, sustainability and command, control and communications.

However, recent history within the Army, as well as other services, points to the importance of integrating MANPRINT considerations early into the system design process. As found in studies conducted by the General Accounting Office, the Department of the Army, the Brookings Institute and others, failure to do so can lead to an observed system performance significantly below the expected system performance level. From a Congressional perspective, the fundamental question put to DOD is: "Are the Armed Forces getting what they are paying for in total system performance or are critical resources being

wasted to acquire high capability technology that exceeds the bounds of human resources?" The Congress formalized these concerns in Section 1208 of the FY 87 Defense Authorization Act. Section 1208 directs the Secretary of Defense to submit a manpower estimate of each major defense acquisition program to the Committees on Armed Services of the Senate and the House of Representatives at least 90 days in advance of approval for development, or production and deployment. The term "manpower estimate" was defined to mean:

> "(A) the total number of personnel (including military civilian, and contractor personnel), expressed both in total personnel and man-years, that will be required to operate, maintain, and support the program upon full operational deployment and to train personnel to operate, maintain and support the program upon full operational deployment;
>
> (B) the increases in military and civilian personnel end strengths that will be required for full operational deployment of the program above the end strengths authorized in the fiscal year in which such an estimate is submitted and the fiscal year in which such an estimate is submitted and the fiscal year or years in which such increases will be required; and
>
> (C) the manner in which such a program would be operationally deployed if no increases in military and civilian end strengths were authorized above the strengths authorized for the fiscal year in which such estimate is submitted."

5.3 MANPRINT PROGRAM AND STATUS

The Army started addressing the need described above in the early 1980's, and the MANPRINT program was conceived in late 1984. During 1985 and 1986 the program focused on building awareness about the program, bringing about the policy changes to make the program a reality, and institutionalizing the program. With the publication of the MANPRINT regulation, AR 602-2, April 1987, MANPRINT is a program that can no longer be considered a passing fancy. It is a program that is here to stay. MANPRINT is developing as planned and considered to be in the early adoption phase. It is anticipated that the acceptance and instationalization of the MANPRINT program will progress in much the same way that the Integrated Logistics System program progressed. The full implementation of the program may require ten or more years.

Key aspects of the program include:

- o Placing MANPRINT requirements in the Required Operational Capability (ROC) statements and the Requests for Proposal (RFP) developed by the Army.
- o Making MANPRINT a separate major area in the source selection process.
- o Improving communications within the Army and with industry through the SMMP, and use of draft ROCs and RFPs which are open to industry to review.
- o Causing industry to consider and include MANPRINT goals and constraints in the weapon systems design process.
- o Evaluating total system performance using the appropriate target audience.
- o Developing procedures and processes to insure that MANPRINT is considered at all key decision points in the acquisition process.
- o Training Army personnel on how to execute the MANPRINT program.
- o Establishing common planning factors as one basis for systematically linking all systems and force level analyses.
- o Supporting research to develop new MANPRINT analytical techniques which are less costly and easier to use.
- o Building congressional, Defense Department and Army support for the program so as to present industry with one customer.

While the Army organization has implemented MANPRINT throughout the acquisition process, industry has taken several approaches in both the management and integration of MANPRINT. MANPRINT has been integrated into existing organizational capabilities, and placed in specialty areas within the organization. Since any one of several potential approaches may adequately support the MANPRINT requirement, the ultimate decision remains with industry.

5.5 FUTURE DIRECTIONS

The full implementation of the MANPRINT program requires the active participation of both the Army and industry. Its success rests on the combined efforts of all communities involved in the acquisition process. In executing the MANPRINT

program, the Army and industry have discovered confusion and misunderstanding over methods and results of analyses. Generally this is due to a lack of standardization of key analytical techniques such as workload and task analysis, lack of operational definition of key planning factors such as performance standards, manning levels, soldier cost factors, usage rates, equipment densities, replacement schemes, and failure to address force level and contingency analyses.

MANPRINT calls for an expanded focus which encompasses the man-machine interface but also addresses the total system-work force interface and environment. The objective of the MANPRINT program is to optimize total system performance. The success and future of the MANPRINT program is in providing decision makers with more complete information and data to assess the numerous variables and alternatives involved in choosing an optimized system design, and in integrating combat, training and material development with personnel resources and capabilities during all phases of the acquisition process. In the future, to provide guidance and gain management visibility over these issues, the Department of Defense is considering changes to DODD 5000.1, 5000.2 and 5000.39. In addition, research efforts are focused on new analytical tools and techniques for workload and manpower requirements estimation, dynamic anthropometrics modeling, rapid prototyping, and man rated simulators tied to Computer Assisted Design systems.

As we look to the future of the MANPRINT program, it is clear that it has started down the road to acceptance. However, it is equally clear that it will not solve all of the system acquisition problems. There will always be some problems that must be managed, however, as the MANPRINT program becomes more fully institutionalized in the acquisition process, the following questions will be answered in the affirmative more frequently:

> "Can this soldier, with this training, perform these tasks, to these standards under these conditions?"
>
> "Can the Army personnel community support the force structure needs imposed by this system, namely, can it recruit, train and distribute the right soldiers at the right time?"

In conclusion, the MANPRINT program is well on its way to becoming an integral part of the way the Army does business. It is demonstrating that MANPRINT issues can be integrated into the acquisition process and can have a positive impact on improving human performance which leads to improved system performance.

APPENDIX A

LIST OF ABBREVIATIONS AND ACRONYMS

AFQT	Armed Forces Qualification Test
AMC	U.S. Army Materiel Command
AMEDD	Army Medical Department
AMMH	Annual Maintenance Man-Hours
AMSAA	(AMC) U.S. Army Materiel Systems Analysis Activity
AOP	Additive Operational Project
AOSP	Army Occupational Survey Program
AP	Acquisition Plan
AR	Army Regulation
ARI	Army Research Institute
ARPRINT	Army Program For Individual Training
AS	Acquisition Strategy
ASAP	Army Streamlined Acquisition Process
ASARC	Army Systems Acquisition Review Council
ASI	Additional Skill Identifier
ASIOE	Associated Support Items of Equipment
ASVAB	Armed Services Vocational Aptitude Battery
ATSC	Army Training Support Center
AURS	Automated Unit Reference Sheet
BCE	Baseline Cost Estimate
BDP	Battlefield Development Plan
BOIP	Basis of Issue Plan
BOIPFD	BOIP Feeder Data
BTA	Best Technical Approach
CBTDEV	Combat Developer
C^2E	Continuous and Comprehensive Evaluation
CDRL	Contract Data Requirements List
CEP	Concept Evaluation Program
CFP	Concept Formulation Package
COEA	Cost and Operational Effectiveness Analysis
CTA	Common Table of Allowances
CTDR	Commercial Training Device Requirement
DA	Department of the Army
DALSO	Department of Army Logistics Staff Officer
DAMPL	DA Master Priority List
DAP	Designated Acquisition Program
DASC	Department of Army System Coordinator
DCP	Decision Coordinating Paper
DCSLOG	Deputy Chief of Staff for Logistics
DCSOPS	Deputy Chief of Staff for Operations
DCSPER	Deputy Chief of Staff for Personnel
DCSRDA	Deputy Chief of Staff for Research, Development and Acquisition
DID	Data Item Description
DMDC	Defense Management Data Center
DOD	Department of Defense
DOD-STD	Department of Defense Standard
DTTP	Doctrine and Tactics Training Plan
E	Environment
ECA	Early Comparability Analysis

ECP	Engineering Change Proposal
EMF	Enlisted Master File
EPMS	Enlisted Personnel Management System
FAT	First Article Testing
FEA	Front End Analysis
FISO	Force Integration Staff Officer
FM	Field Manual
FOT&E	Follow-on Operational Test and Evaluation
FUE	First Unit Equipped
FYDP	Five-Year Defense Program
HARDMAN	Hardware versus Manpower
HEL	Human Engineering Laboratory
HFE	Human Factors Engineering
HFEA	Human Factors Engineering Analysis
HHA	Health Hazard Assessment
HHAR	Health Hazard Assessment Report
ICE	Independent Cost Estimate
ICTP	Individual and Collective Training Plan
IEP	Independent Evaluation Plan
IER	Independent Evaluation Report
ILS	Integrated Logistics Support
ILSP	Integrated Logistics Support Plan
IOC	Initial Operational Capability
IPR	In-Process Review
IPS	Integrated Program Summary
IR&D	Independent Research and Development
JMSNS	Justification for Major System New Start
JRMB	Joint Requirements and Management Board
JTA	Joint Table of Allowances
LCSMM	Life Cycle System Management Model
LOA	Letter of Agreement
LOGSACS	Logistics Structure and Composition System
LRRDAP	Long-Range Research, Development, and Acquisition Plan
LSA	Logistics Support Analysis
LSAR	Logistics Support Analysis Record
MAA	Mission Area Analysis
MACOM	Major Army Command
MADP	Materiel Acquisition Decision Process; Mission Area Deployment Plan
MAMP	Materiel Acquisition Management Plan; Mission Area Materiel Plan
MANPRINT	Manpower and Personnel Integration
MARC	Manpower Requirements Criteria
MATDEV	Materiel Developer
MDEP	Management Decision Package
MDV	MANPRINT Domain Verification
MEPSCAT	Military Entrance Physical Strength Capacity Tests
MFA	Mission Functional Analysis
MIL-STD	Military Standard
MJWG	MANPRINT Joint Working Group
MOS	Military Occupational Specialty
MPT	Manpower Personnel Training
MPTTA	Manpower, Personnel and Training Trade-off Analysis

MRSA	U.S. Army Materiel Readiness Support Activity
MSA	MPT Sensitivity Analysis
MSC	Major Subordinate Command
MTBF	Mean Time Between Failure
MTTR	Mean Time to Repair
NDI	Nondevelopment Item
NETP	New Equipment Training Plan
NTC	National Training Center
O&O	Operational and Organizational
OBCE	Operational Baseline Cost Estimate
ODCSOPS	Office of the Deputy Chief for Operations and Plans
ODCSPER	Office of the Deputy Chief of Staff for Personnel
OMA	Operation and Maintenance, Army
OMF	Officer Master File
OSE	Other Support Equipment
OTEA	U.S. Army Operational Test and Evaluation Agency
OTP	Outline Test Plan
P^3I	Pre-Planned Product Improvement
P_e	Equipment Performance
P_h	Human Performance
P_s	System Performance
PDM	Program Decision Memorandum
PERSACS	Personnel Structure and Composition System
PERSSO	Personnel System Staff Officer
PHL	Preliminary Hazards List
PIP	Product Improvement Program; Product Improvement Proposal
PM	Program Manager/Project Manager/Product Manager
PM TRADE	Project Manager, Training Devices
PMAD	Personnel Management Authorization Document
PMCS	Program Management Control System
PMD	Program Management Document
POI	Program(s) of Instruction
POM	Program Objective Memorandum
PPBES	Planning, Programming, Budgeting, and Execution System
PULHES	P-Physical capacity or stamina; U-Upper extremities; L-Lower extremities; H-Hearing and ears; E-Eyes; and S-psychiatric
QQPRI	Qualitative and Quantitative Personnel Requirements Information
RAM	Reliability, Availability, and Maintainability
RDA	Research, Development and Acquisition
RDTE	Research, Development, Test, and Evaluation
RFP	Request for Proposal
RFQ	Request for Quotation
ROC	Required Operational Capability
SAR	Safety Assessment Report
SCP	System Concept Paper
SDC	Sample Data Collection
SECDEF	Secretary of Defense
SMMP	System MANPRINT Management Plan
SOW	Statement of Work

SPE	System Performance Estimation
SQI	Skill Qualification Identifier
SQT	Skill Qualification Test
SSC-NCR	Soldier Support Center-National Capital Region
SSG	Special Study Group
STF	Special Task Force
TC	Type Classification
TDA	Table of Distribution and Allowances
TDAC	Training Data Analysis Center
TDP	Test Design Plan
TDR	Training Device Requirement
TEA	Training Effectiveness Analysis
TEMP	Test and Evaluation Master Plan
TIWG	Test Integration Working Group
TMDE	Test, Measurement, and Diagnostic Equipment
TOA	Trade-off Analysis
TOD	Trade-off Determination
TOE	Table of Organization and Equipment
TPCA	Task Performance Capability Analysis
TPRA	Task Performance Requirements Analysis
TRAC	TRADOC Analysis Center
TRADOC	U.S. Army Training and Doctrine Command
TRASSO	TRADOC System Staff Officer
TSARC	Test Schedule and Review Committee
TSG	The Surgeon General
TSM	TRADOC System Manager
TTHS	Trainees, Transfers, Hospitals, and Schools
TT/UT	Technical Test/User Test
UIC	Unit Identification Code
WSSM	Weapon System Staff Manager
WSSO	Weapon System Support Officer

APPENDIX B

GLOSSARY

ACQUISITION PLAN (AP)

The Acquisition Plan is derived from the Acquisition Strategy and summarizes acquisition background and need, objectives, conditions, strategy, and related functional planning (with emphasis on contractual aspects). It provides detailed planning for contracts and milestone charting.

ACQUISITION STRATEGY

The conceptual framework for conducting materiel acquisition, encompassing the broad concepts and objectives which direct and control the overall development, production, and deployment of a materiel system. It evolves in paralleled with the system's maturation. Acquisition strategy must be stable enough to provide continuity, but dynamic enough to accommodate change. It is documented as an annex to the DCP at Milestone I.

ADDITIONAL SKILL IDENTIFIER (ASI)

Consists of a letter and a number and may be added to the basic five-character MOS code to identify certain highly specialized skills that are in addition to the skills required by the MOS.

ADDITIVE OPERATION PROJECT (AOP)

A project that consists of equipment requirements besides the initial issue allowances in MTOE, TDA, and CTA. It automatically increases the Army acquisition objective (AAO) by the quantities cited in the project. It is an authorization for major commands to acquire materiel for theaters or CONUS stockage for the purpose of supporting specific operations, contingencies, or war plans for specific geographic areas and worldwide base development.

ANTHROPOMETRIC

Of or relating to the study of human body measurements, especially on a comparative basis.

ARMED FORCES QUALIFICATION TEST (AFQT)

The AFQT is a combination of Verbal (VE), Arithmetic Reasoning (AR), and Numerical Operations (NO) ASVAB (see next entry) subtests. The AFQT is used to screen out applicants whose mental characteristics are not sufficient for Army duties. AFQT composite is a good general

intelligence test as well as a practical index of reading ability.

ARMED SERVICES VOCATIONAL APTITUDE BATTERY (ASVAB)

The Armed Services Vocational Aptitude Battery (ASVAB) consists of a series of subtests which when combined in various ways produce 11 composite scores. These composites are used for two purposes: (1) selection of applicants, and (2) assignment of new accessions.

Composites are used to assign new accessions to MOSs which have a need for personnel with the requisite aptitudes in specific areas. Most MOSs have entry requirements involving a minimum score on one or more of the ASVAB composites. For instance, MOS 688 (Aircraft Power Plant Repairer) requires a score of 100 on the Mechanical Maintenance (MM) composite for entry into the MOS.

The ASVAB composites are good predictors for entry level personnel in diagnostic, procedural, administrative, and clerical types of tasks, which probably represents 90 percent of the jobs in enlisted MOSs. There is substantial confidence that assignment to job categories by ASVAB composites is considerably better than chance.

ARMY OCCUPATIONAL SURVEY PROGRAM (AOSP)

With the cooperation of service schools, AOSP does research on Military Occupational Specialties (MOS's). Using soldier tasks as the basic units of analysis, data are collected on such variables as percent performing, task learning difficulty and relative time spent. After the survey data have been analyzed, a report on the MOS is prepared.

ARMY PROGRAM FOR INDIVIDUAL TRAINING

A computer-developed document that identifies officer and enlisted training requirements. It also contains programs for the Active Army, Reserve Components, other U.S. Services, and foreign military.

ASSOCIATED SUPPORT ITEMS OF EQUIPMENT (ASIOE)

An end item required for the operation, maintenance, and/or transportation of a BOIP item. ASIOE's are listed on the BOIP of the item they support. ASIOE's have their own LIN and are separately documented into TOE/VTAADS.

AUTOMATED UNIT REFERENCE SHEET (AURS)

A document which, generally, proposes or portrays certain basic personnel and equipment data for organizational development. It provides information for use in developing BOIP and Draft Plan TCE to support concepts and doctrine

studies, computer assisted war game simulations, and operational testing.

AVAILABILITY (OPERATIONAL)

A measure of the degree to which a system is either operating or is capable of operating at any time when used in its typical operational and support environment.

BASELINE COST ESTIMATE (BCE)

A document prepared by the materiel developer; detailed estimate of acquisition and ownership normally required for high level decisions; provides the basis for subsequent tracking and auditing.

BASIS OF ISSUE PLAN (BOIP)

A planning document that lists specific levels at which a new item of materiel may be placed in a unit/organization; the quantity of the item proposed for each organization element; and other equipment and personnel changes required as a result of the introduction of the new item. The BOIP is not an authorization document.

BEST TECHNICAL APPROACHES (BTA)

A document prepared by a Special Task Force (STF) or Special Study Group (SSG), or jointly by the combat developer and materiel developer during concept exploration. It identifies the best general technical approach(es) based on the results of the Trade-off Determination (TOD) and an analysis of trade-offs among support concepts, technical concepts, life cycle costs, and schedules.

BIOMEDICAL

Of or relating to a branch of medical science concerned especially with the capacity of human beings to survive and function in abnormally stressing environments and with the protective modification of such environments.

COMMON TABLE OF ALLOWANCES (CTA)

An authorization document for items needed for common usage by individuals and by MTOE, TDA, or JTA units and activities Army-wide.

CONCEPT FORMULATION PACKAGE (CFP)

The documentary evidence that the concept formulation effort has satisfied the concept formulation objectives. The package consists of a Trade-Off Determination (TOD), Trade-Off Analysis (TOA), Best Technical Approach (BTA), and Cost and Operational Effectiveness Analysis (COEA).

CONTINUOUS COMPREHENSIVE EVALUATION (C^2E)

A continuous process extending from concept definition through deployment, which evaluates the operational effectiveness and suitability of a system by analyses of all available data.

CONTRACT DATA REQUIREMENTS LIST (CDRL)

A form (DD Form 1423) used as the sole list of data and information which the contractor will be obligated to deliver under the contract, with the exception of that data required by standard Defense Acquisition Regulation (DAR) clauses.

COST AND OPERATIONAL EFFECTIVENESS ANALYSIS (COEA)

A documented investigation of the comparative effectiveness of alternative means to meet a defined threat. The cost of developing, producing, distributing, and sustaining each alternative system in a military environment for a time preceding the combat application. Also, a documented investigation of a valid requirement that HQ TRADOC and HQDA have approved.

COST AND TRAINING EFFECTIVENESS ANALYSIS (CTEA)

A methodology which involves documented investigation of the comparative effectiveness and costs of alternative training systems for attaining defined performance objectives, taking into consideration usage pattern and training scenarios. A CTEA can examine training concepts, training equipment, training strategies, programs of instruction, training implications of new materiel, organization, tactics, employment techniques, or families of systems. CTEA is used in conjunction with the COEA.

CRITICAL ISSUE

Those issues associated with the development of an item or system that are of primary importance to the decision authority in reaching a decision to allow the item or system to continue into the next phase of development.

DECISION COORDINATING PAPER (DCP)

A decision paper that gives the reason for starting, continuing, reorienting, or stopping a development program at each critical decision point during the acquisition process.

DESIGNATED ACQUISITION PROGRAM (DAP)

A program designated by the AAE for ASARC milestone review. Selection is based on resource requirements, complexity and Congressional interest.

DEVELOPMENT TESTING (DT)

Testing of materiel systems conducted by the materiel developer using the principle of a single, integrated development test cycle to demonstrate that the design risks have been minimized, that the engineering development process is complete, and that the system will meet specifications; and to estimate the system's military utility when it is introduced. DT is conducted in factory, laboratory, and proving ground environments.

EMBEDDED TRAINING

Training that is delivered by an equipment system in addition to the primary operational function. The training is made available by components of the equipment that take advantage of the overall system capabilities.

ENLISTED MASTER FILE (EMF)

A file which contains personnel record data on every enlisted individual. From this file "breakouts" of ASVAB scores and associated data can be obtained for every soldier in a given MOS.

FIRST ARTICLE TEST (FAT)

Production testing that is planned, conducted, and monitored by the materiel developer. FAT includes pre-production and initial production testing conducted to ensure that the contractor can furnish a product that meets the established technical criteria.

FIRST UNIT EQUIPPED (FUE)

The first troop unit to be equipped with the first production items/systems. (DA PAM 700-127)

FIRST UNIT EQUIPPED (FUE) DATE

The schedule date a system or end item and its agreed upon support elements are issued to the designated initial operational capability unit and training specified in the new equipment training plan has been accomplished.

FOLLOW-ON EVALUATION

Testing conducted subsequent to the full production decision to provide data to answer operational issues that were not resolved by earlier operational testing.

FOLLOW-ON OPERATIONAL T&E

Test and evaluation conducted subsequent to a Milestone III production decision to obtain information lacking from

earlier initial operational test and evaluation. Normally, FOT&E is conducted subsequent to the decision to proceed beyond low rate initial production.

HEALTH HAZARD

An existing or likely condition, inherent to the operation or use of materiel, that can cause death, injury, acute or chronic illness, disability and/or reduced job performance of personnel by exposure to:

- o Shock/Recoil
- o Vibration
- o Noise (including steady state, impulse, and blast overpressure)
- o Humidity
- o Toxic Gases
- o Toxic Chemicals
- o Ionizing or non-ionizing radiation (including X-rays, gamma rays, magnetic fields, microwaves, radio waves, and high intensity light).
- o Lasers
- o Heat and Cold
- o Oxygen Deficiency
- o Blunt/sharp Trauma
- o Pathogenic Microorganisms

HEALTH HAZARD ASSESSMENT (HHA)

The application of biomedical and psychological knowledge and principles to identify, evaluate, and control the risks to the health and effectiveness of personnel who test, use, or service Army systems.

HIGH DRIVER TASK

A task identified, through analysis of task criteria, as costly in manpower, personnel and training resources. The primary objective of ECA is to aid Combat Developers in identifying "high drivers" requiring a design change so that these tasks can be reduced in number or completely eliminated from new system design. Information from tasks derived from predecessor or reference systems are the key to determining the impact these tasks have on the Army MPT resources.

HUMAN FACTORS ENGINEERING ANALYSIS (HFEA)

HFE deals with the comprehensive integration of soldier characteristics into Army doctrine and systems. It is used in system definition, design, development and evaluation in order to optimize the capabilities and performance of human-machine combinations. It includes the principles and techniques of the science of human engineering, and covers all aspects of the soldier-machine interface.

Application of human factors engineering involves considerations of all relevant information pertaining to the following:

- o Human characteristics
- o Anthropometric data
- o System interface requirements
- o Human performance
- o Biomedical factors
- o Safety factors

In addition, human factors engineering analyses pertaining to the following are used as inputs to the consideration of Manpower, Personnel, and Training issues in the MAP.

- o System manning levels
- o User, operator and maintainer capability requirements

The adequacy of system HFE is evaluated during both development and operational testing.

IN-PROCESS REVIEW (IPR)

Army acquisition programs other than DOD major or Designated Acquisition Programs.

INDIVIDUAL AND COLLECTIVE TRAINING PLAN (ICTP)

The plan that identifies the training concept, strategy, and requirements for the system from initial qualification through sustainment and follow-on training for all MOS and at all levels.

INTEGRATED LOGISTIC SUPPORT

A composite of all support considerations necessary to assure the effective and economical support of a system at all levels of maintenance for its programmed life cycle. A unified and iterative approach to the management and technical activities needed to:

a. Influence operational and materiel requirements and design specifications.

b. Define the support requirements best related to system design and to each other.

c. Develop and acquire the required support.

d. Provide required operational phase support at lowest cost.

e. Seek readiness and LCC improvements in the materiel system and support systems during the operational life-cycle.

f. Repeatedly examine support requirements throughout the service life of the system.

INTEGRATED LOGISTIC SUPPORT PLAN

Provides a composite of all support considerations necessary to assure the effective and economical support of a system for its life cycle and serves as the source document for summary and consolidated information required in other documents of the program management documentation.

INTEGRATED PROGRAM SUMMARY

Summarizes, in greater detail than the DCP, various facets of the implementation plan for a system acquisition at Milestones I and III.

JOB ANALYSIS

The basic method used to obtain salient facts about a job, involving observation of workers, conversations with those who know the job, analysis questionnaires completed by job incumbents, and study of documents involved in performance of the job. (See also AR310-25.)

JOINT TABLE OF ALLOWANCES (JTA)

The JTA is a requirements/authorization document of equipment for units operated jointly by two or more military services, such as MAAG and missions.

JUSTIFICATION FOR MAJOR SYSTEM NEW START (JMSNS)

Defines a deficiency or opportunity such that there is a reasonable probability of satisfying a need by the acquisition of a single system.

LEARNING ANALYSIS

A procedure for identifying the supporting skills and knowledge of each stated objective that must be acquired before a soldier can demonstrate mastery of the objectives themselves.

LOGISTIC SUPPORT ANALYSIS (LSA)

An analytical technique used by integrated logistic support management to provide a continuous dialogue between designers and logisticians. LSA provides a system to identify, define, analyze, quantify, and process logistics support requirements for materiel acquisition programs.

LOGISTIC SUPPORT ANALYSIS RECORD (LSAR)

File of logistic support information in standardized format, on acquisition programs for specific new or modified systems

and equipment. Serves acquisition process using logistic data derived during all phases of the process to support logistic support analysis processes.

LONG RANGE RESEARCH, DEVELOPMENT AND ACQUISITION PLAN

Two basic plans make up the overall Army Long-Range Plan; they are discussed below. (a) the DA Long-Range RDA (LRRDA) Plan. This plan displays R&D programs in support of requirements identified by MAAs and summarized in the Battlefield Development Plan Portrays programs over a 15-year period, displays RDT&E programs that support procurement, is fully compatible with the PPBES, reflects a by-year prioritization, and is the starting point for RDA program building. (b) the AMC LRRDA Plan. This plan consists of two parts, as follows: (1) the AMC Long-Range Science and Technology Plan. This plan defines technology in terms of deliverables to solve system deficiencies identified by MAAs. Provides a document which identifies technology base efforts (6.1, 6.2, and 6.3A) being conducted by major subordinate commands and laboratories, and provides management a baseline for decisions affecting technology base efforts. Serves as a means of communicating to the user those technologies that will improve mission performance in the 10 to 20 year future. (2) the AMC Long-Range Development and Acquisition Plan (AMC LRRDAP). This plan specifies system development time lines and the relationship between the technical base and planned developments and acquisitions.

MANPOWER

The personnel strength (military and civilian) as expressed in terms of the number of men and women available to the Army.

Consideration of the net effect of Army systems and items on overall Army human resource requirements and authorizations (spaces, to ensure that each system is affordable from the standpoint of manpower). It includes analysis of the number of people needed to operate, maintain, and support each new system being considered or acquired, including maintenance and supply personnel and personnel to support and conduct training. It requires a determination of the Army manpower changes generated by the system, comparing the new manpower needs with those of the old system(s) being replaced, and an assessment of the impact of the changes on the total manpower limits of the Army. If, given manpower priorities established by the Department of the Army, systems cannot be supported by projected manpower resources, then changes in system design, organization, or doctrine are made to achieve affordability. In the MAP, manpower analyses and actions are necessarily conducted in conjunction with force structure and budget processes.

MANPOWER REQUIREMENTS CRITERIA (MARC)

The number of direct workers required to effectively perform a specified work activity.

A principal computational component of MARC is the estimate of Annual Maintenance Man Hours (AMMH) and its variations (AAMMH, IPAMMH, and DPAMMH), each of which represents different contributing factors to the overall maintenance manpower and personnel determination. AAMMH, AMMH, DPAMMH and IPAMMH are MARC components of a system from the perspective of the factors each represents. These MARC components are defined below:

Annual Available Maintenance Man Hours (AAMMH).

The number of annual man-hours each repairer is expected to be available under sustained operating conditions (e.g., wartime).

Annual Maintenance Man Hours (AMMH).

The sum of the direct and indirect productive time required to repair an item.

Direct Productive Annual Maintenance Man Hours (DPAMMH).

The estimated wrench-turning time required to repair a component or assembly.

$$DPAMMH = \frac{\text{Equipment Usage Rate}}{\text{Mean Time Between Repair}} \times \text{Mean Time To Repair}$$

MANPRINT (MANPOWER AND PERSONNEL INTEGRATION)

MANPRINT refers to the comprehensive technical effort to identify and integrate into materiel development and acquisition (to assure system effectiveness) all relevant information and considerations concerning:

1. Human factors engineering
2. Manpower
3. Personnel
4. Training
5. System Safety
6. Health Hazards

This comprehensive effort occurs prior to, during, and after the materiel acquisition process (MAP).

MARKET INVESTIGATION

-rocess of gathering information before making acquisition decisions. Conducted initially during the

Requirements/Technology Base Activities Phase and, in greater depth, during the Proof of Principle Phase.

MATERIEL ACQUISITION DECISION PROCESS REVIEWS (MADP)

Major management decision reviews conducted prior to entry into each successive phase of the materiel acquisition process. The purpose of the reviews is to evaluate the development and surface critical issues prior to approval for entry into the subsequent phase. There are three levels of reviews:

a. The Defense System Acquisition Review Council (DSARC) reviews for major systems requiring the Secretary of Defense approval of program decisions. After a weapons program progresses beyond DSARC II, the Service Secretaries assume responsibility for surveillance as directed by the Deputy Secretary of Defense.

b. The Army Systems Acquisition Review Council (ASARC) reviews for major systems requiring the Secretary of the Army approval of program decisions, including those requiring subsequent approval by the SECDEF.

c. In-process Reviews (IPR) for nonmajor system.

MATERIEL ACQUISITION PROCESS (MAP)

The sequence of acquisition activities starting with the identification of an unmet mission need and extending through the introduction of a system into operational use.

MATERIEL RELEASE PROCESS

The authority granted by the designated officer to issue materiel to the user.

MILITARY OCCUPATIONAL SPECIALTY (MOS)

A term used to identify a grouping of duty positions possessing such close occupational or functional relationship that an optimal degree of interchangeability among persons so classified exists at any given skill level.

MISHAP DATA BASE

The Army Safety Management Information (ASMIS) which 's designed to be user friendly and conversational with a wide variety of computer terminals or minicomputers via A voice grade telephone lines provides for rapid access of information from safety offices throughout the Army.

ASMIS consists of data recorded from:

DA Form 285
Preliminary reports of aviation mishaps (PRAM)

DA Forms 2397
Federal Employees Compensation Act data
Aviation flying hours
DA Forms 2398
Safety library

The system may be accessed by the use of appropriate user identification code and password.

MISSION AREA ANALYSIS (MAA)

An assessment of the capability of a force to perform within a particular battlefield or functional area. The analysis is designed to discover deficiencies in doctrine, organizations, training, and materiel and to identify means of correcting these deficiencies; stressing first doctrinal solutions, then training solutions, then organizational solutions, and lastly, materiel solutions. MAA also provides a basis for applying advanced technology to future Army operations.

MISSION AREA DEVELOPMENT PLAN (MADP)

Transitions the MAA corrective actions to specific projects with milestone schedules so that resources can be applied to the elimination of the MAA deficiency. Each mission area proponent (TRADOC school) publishes a MADP annually. MADP contains sections on materiel, doctrinal, organizational, and training corrective actions.

NON-DEVELOPMENT ITEM (NDI)

Those items determined by a Materiel Acquisition Decision Process (MADP) Review (i.e., DSARC, ASARC, or IPR, as appropriate to be available for acquisition to satisfy an approved materiel requirement with no expenditure of Army research, development, test, and evaluation (RDTE) funds for development, modification, or improvement. The item may be a commercial product or an item which has been developed and used by another Service, county, or government agency.

OPERATIONAL AND ORGANIZATIONAL PLAN OR O&O PLAN

An operational, organizational, training, and logistical plan for the employment of specific hardware systems within Army organizations. O&O Plans are based on operational concepts and are developed in conjunction with those concepts. Each O&O Plan should be able to trace its lineage through one or more functional concepts to the basic (umbrella) concept.

OPERATIONAL BASELINE COST ESTIMATE

OPERATIONAL TESTING (OT)

Testing and evaluation of materiel systems accomplished with typical user operators, crews, or units in as realistic an operational environment as possible to provide data for estimating:

a. The military utility, operational effectiveness, and operational suitability (including compatibility, interoperability, reliability, availability, maintainability, supportability, operational man (soldier)-machine interface, and training requirements) of new systems.

b. From the user viewpoint, the system's desirability considering systems already available and the operational benefits and/or burdens associated with the new system.

c. The need for modification to the system.

d. The adequacy of doctrine, organization, operating techniques, tactics, and training for employment of the system; and, when appropriate, its performance in a countermeasures environment. (AR 70-10, AR 71-3)

OUTLINE TEST PLAN (OTP)

The formal document included in the Five Year Test Plan (FYTP) containing administrative information; and the test purpose, objective, scope, tactical context, resource requirements, and costs estimates. Once approved by DA, the OTP becomes a tasking document.

PERSONNEL

Military and civilian persons of the skill level and grades required to operate and support a system, in peacetime and war.

Consideration of the ability of the Army to provide qualified people--in terms of specific skills, experience and other human characteristics--needed to use, operate, maintain and support Army systems or items. It requires detailed assessment of the aptitudes which soldiers must possess in order to complete training and use, operate and/or maintain the system successfully. Iterative analyses must be accomplished as integral components of the new system design process, comparing projected quantities of qualified personnel with requirements of the new system, any system(s) being replaced, overall Army needs for similarly qualified people, and priorities established by the Department of the Army. As necessary, the system is configured specifically to accommodate the probable capabilities of personnel projected to be available, so that the new system is supportable from a personnel standpoint. Analysis of

specific system personnel requirements using human factors engineering is necessary for each system design option considered, using "best available" information early in the acquisition process and improved information as the system design becomes firmer. Personnel analyses must consider not only simple availability, but also the capability of the Army personnel management system to provide the needed numbers of properly qualified people at a reasonable cost. Personnel must be included in system life cycle cost estimates and system design tradeoffs -- machine costs versus personnel costs. Personnel analyses and projections are needed in time to allow orderly recruitment, training and assignment of personnel in conjunction with equipment fielding.

PLANNING, PROGRAMMING, BUDGETING AND EXECUTION SYSTEM

An integrated system for the establishment, maintenance and revision of the FYDP and the DOD budget.

PRELIMINARY HAZARD ANALYSIS (PHA)

As implied by the title, PHA is the initial effort in hazard analysis during the system design phase or the programming and requirements development phase for facilities acquisition. It may also be used on an operational system for the initial examination of the state of safety. The purpose of the PHA is not to affect control of all risks but to fully recognize the hazardous states with all of the accompanying system implications.

PRELIMINARY HAZARDS LIST (PHL)

The PHL provides to the materiel developer a list of hazards that may require special safety design emphasis or hazardous areas where in-depth analyses need to be done. The MATDEV may use the results of the PHL to determine the scope of follow-on hazard analyses.

PREPLANNED PRODUCT IMPROVEMENTS

Planned future evolutionary improvement of developmental systems for which design considerations are effected during development to enhance future application of projected technology. Include improvements planned for ongoing systems that go beyond the current performance envelope to achieve a needed operational capability.

PRODUCT IMPROVEMENT PROGRAM (PIP)/PRODUCT IMPROVEMENT PROPOSAL

A program to incorporate a configuration change involving engineering and testing effort on major end items and depot repairable components or changes on other than developmental items to increase system/combat effectiveness or extend the useful military life.

PROPOSAL:

A reconfiguration of an end item of Army or multi-service materiel type-classified standard that is funded, managed, and completed as a single project. The term "PIP" is applied to the project from its start as a proposal through its completion. A PIP is initially constituted in the form of a PIP package and its status is periodically reported on Product Improvement Information Reports (PRIMIRs).

PROGRAM MANAGEMENT CONTROL SYSTEM (PMCS)

Consists of management actions in a single interacted process to control selected programs and their costs.

PROGRAM OBJECTIVES MEMORANDUM

A document submitted to the SECDEF by the heads of the DOD Components which recommends the total resource requirements within the parameters of the SECDEF fiscal guidance.

PROTOTYPES

A model suitable for evaluation of design, performance, and production potential.

RELIABILITY

A fundamental characteristic of materiel expressed as the probability that an item will perform its intended function for a specified interval under stated conditions. Durability is a special case of reliability.

RELIABILITY, AVAILABILITY, MAINTAINABILITY (RAM)

RAM requirements are those imposed on materiel systems to insure they are operationally ready for use when needed, will successfully perform assigned functions and can be economically operated and maintained within the scope of logistics concepts and policies. RAM programs are applicable to materiel systems, test measurement and diagnostic equipment (TMDE), training devices and facilities developed, produced, maintained, procured or modified for Army use. Reliability is the duration of probability of failure free performance under stated conditions. Availability is a measure of the degree to which an item is in operable and committable state at the start of the mission. Maintainability is the ability of an item to be retained in or restored to specified condition within a given time when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources, at each prescribed level of maintenance and repair.

REQUEST FOR PROPOSAL (RFP)

Request for the manufacturer to submit a proposal supported by cost breakdown. It provides a description of the items to be procured. It may include specifications, quantities, time and place of delivery, method of shipment, packaging and instruction manual requirements, materiel to be furnished, and data requirements, both support and administrative.

REQUIRED OPERATIONAL CAPABILITY

A document which states concisely (usually in four pages or less) the minimum essential operational, technical, logistical, and cost information necessary to initiate full-scale development or procurement of a materiel system.

RESIDUAL HAZARDS

Hazards that are not eliminated by design.

RETROFIT

The application of measures or controls to correct deficiencies in fielded systems.

SAFETY ASSESSMENT REPORT

A formal summary of the safety data collected during the design and development of the system. In it, the materiel developer summarizes the hazard potential of the item, provides a risk assessment, and recommends procedures or other corrective actions to reduce these hazards to an acceptable level.

SAMPLE DATA COLLECTION (SDC)

A method for obtaining information on the performance and maintainability of an item of equipment. Data are obtained directly from observations made in the field. An effort is made to see that the sample from which the feedback is obtained is representative of the total population.

SOLDIER/MACHINE INTERFACE

Consideration through system analysis and psychophysiology of equipment design and operational concepts to insure they are compatible with the capabilities and limitations of operators and maintenance personnel. Also referred to as soldier-materiel interface and soldier-machine interaction.

SOURCE SELECTION EVALUATION (SSE)/SOURCE SELECTION PROCESS

The process wherein the requirements, facts, recommendations and Government policy relevant to an award decision in a

competitive procurement of a system/project are examined and the decision made.

SPECIAL STUDY GROUP (SSG)

Group chartered by the CBTDEV and normally composed of representatives of HQDA, CBTDEV, operational tester, MATDEV, logistician trainer and PM designee, convened during Requirements/Technology Base Activity phase to conduct analysis, insure inclusion of all alternatives within an analysis, monitor experimentation, or undertake other such tasks that may require concentration of special expertise for a short duration. Normally chaired by a CBTDEV representative. MATDEV representative on the SSG develops the Acquisition Strategy (AS).

A group, normally composed of representatives of HQDA, combat developer, operational tester, materiel developer, logistician, and trainer, and the project manager designee, which is convened to conduct analysis, ensure inclusion of all alternatives within an analysis, monitor experimentation, or undertake other such tasks that may require the concentration of special expertise for a short duration.

SPECIAL TASK FORCE

A group that is normally composed of the chartered task force director and representatives of the user, materiel developer, trainer, combat developer, HQDA, and operational tester, and the project manager designee. This task force conducts an in-depth investigation of the need for the system described in the requirements documents and of any necessary alternative system designs, monitors experimentation, and arrives at a recommended approach to provide the system described in an approved ROC document.

SUPPORTABILITY

That characteristic of materiel indicative of its ability to be sustained at a required readiness level when supported in accordance with specified concepts and procedures.

SYSTEM

A composite, at any level of complexity, of personnel, procedures, materials, tools, equipment, facilities, and software. The elements of this composite entity are used together in the intended operational or support environment to perform a given task or achieve a specific production, support, or mission requirement.

SYSTEM SAFETY

The application of engineering and management principles, criteria, and techniques to optimize safety within the

constraints of operational effectiveness, time, and cost throughout all phases of the system or facility life cycle.

SYSTEM SAFETY PROGRAM PLAN

A description of the planned methods to be used by the contractor to implement the tailored requirements of MIL-STD 8828, including organizational responsibilities, resources, methods of accomplishment, milestones, depth of effort, and integration with other program engineering and management activities and related systems.

TABLE OF DISTRIBUTION AND ALLOWANCES (TDA)

The TDA is a requirements/authorization document which prescribes the organizational structure, personnel and equipment authorizations, and requirements of a military unit to perform a specific mission for which there is no appropriate TOE.

TABLE OF ORGANIZATION AND EQUIPMENT (TOE)

The TOE is a table which prescribes the normal wartime mission, organizational structure, and personnel and equipment requirements for a military unit, and is the basis for an authorization document, the MTOE. The TOE is not an authorization document.

TARGET POPULATION

The population defined for a training developments effort to ensure the training products produced are compatible with the personnel in the field or to establish the parameters for the baseline (skills and knowledges) entry point for any officer or enlisted specialty training requirement.

TASK ANALYSIS

A process of reviewing actual job content and context to classify information into units of work within a job. The process provides a procedure for isolating each unique unit of work, provides a procedure for describing each unit accomplished and provides descriptive information to assist in the design and testing of training products.

TECHNICAL DATA PACKAGE (TDP)

A generic term applicable to types of technical data when used for procurement purposes. It is a composite of specifications, plans, drawings, standards, and such other data as may be necessary to describe existing materiel so they may be procured by the method contemplated.

TECHNOLOGY BASE

The Army's science and technology base consisting of research (6.1), and exploratory development (6.2).

TEST AND EVALUATION MASTER PLAN (TEMP)

A document used in the Army review and decision process to assess the adequacy of the planned testing and evaluation. It is prepared for all defense system acquisition programs. The TEMP is a broad plan that relates test objectives to required system characteristics and critical issues and integrates objectives, responsibilities, resources, and schedules for all T&E to be accomplished. Replaces Coordinated Test Plan (CTP).

TEST DESIGN PLAN (TDP)

A formal document developed by the test organization which states the circumstances under which a test and/or evaluation will be executed, the data required from the test, and the methodology for analyzing test results.

TEST INTEGRATION WORKING GROUP (TIWG)

A formally chartered organization chaired by the materiel developer and having as a minimum membership representatives (with authority to act for their respective commands/activities) from the combat developer, the logistician, the operational tester, the materiel developer and, when appropriate, the contractor. The primary purpose of the TIWG is to provide a forum for direct communication to facilitate the integration of test requirements and speed up the TEMP coordination process. The objective of the TIWG is to reduce costs by integrating testing to the maximum extent, eliminate redundant testing and facilitate the coordination of test planning, interchange of test data and use of test resources to achieve cost-effective testing.

TEST SUPPORT PACKAGE (TSP)

Test support packages are provided by the proponent materiel developer and the combat developer/trainer. The proponent materiel developer provides packages consisting of the maintenance support for the item/system and a new equipment training package. The combat developer/trainer provides the following; statement of doctrine and techniques for employment, statement of organization and basis of issue and training plan, statement of logistic support concepts, mission profiles, statement of suitable threat for test and a description of test setting, including terrain and friendly forces situations.

TRADE-OFF ANALYSIS (TOA)

A document prepared by an STF or SSG, or jointly by the combat and materiel developers, to determine which technical approach offered in the TOD is best.

TRADE-OFF DETERMINATION

The document prepared by the materiel developer. It is sent to the combat developer or to an STF or SSG to convey the feasibility of a potential system. Included are technical risks related to each approach, estimated RDTE and procurement costs and schedules.

TRAINING

Consideration of the training necessary and time required to impart the requisite knowledge, skills, and abilities to qualify Army personnel for use, operation, maintenance and support of Army systems or items. It involves (1) the formulation and selection of engineering design alternatives which are supportable from a training perspective, (2) the documentation of training strategies, and (3) the timely determination of resource requirements to enable the Army training system to support system fielding. Human factors engineering techniques are used to determine the tasks which must be performed by system user, operator, maintenance and support personnel; the conditions under which they must be performed; and the performance standards which must be met. Training is linked with personnel analyses and actions in that availability of qualified personnel is a direct function of the training process. As a minimum, the following must be considered:

- o Training effort and costs versus system design;
- o Training times
- o Training program development, considering aptitudes of available personnel
- o Sustainment training, as distinguished from training associated with initial system fielding
- o Developmental training, as distinguished from Initial Entry Training
- o Training devices--design, development and use
- o Training base resourcing--manpower and personnel implication
- o New Equipment Training (NET)
- o Formal training base instruction, versus on-the-job training (OJT) in units
- o Unit training
- o Operational testing of the adequacy of training programs and techniques

TRAINING DEVICE (TD)

Any three-dimensional object developed, fabricated or procured specifically for improving the learning process.

Training devices may be either system devices or non-system devices.

a. System devices are designed for use with one system or item of equipment, including subassemblies and components.

b. Non-system devices are designed to support general military training and/or for use with more than one system or item of equipment, including subassemblies and components.

TYPE CLASSIFICATION (TC)

Identifies the life cycle status of a materiel system by the assignment, after a production decision by the appropriate authority, of a type classification designation and records the status of a materiel system in relation to its overall life history as a guide to procurement, authorization, support, asset and readiness reporting.

APPENDIX C

TARGET AUDIENCE DESCRIPTION

1. Definition.

A target audience description provides information regarding the quantity and qualifications of the soldiers or civilians who will operate, maintain and support the weapons system. It should describe the range of individual qualifications on all relevant physical, mental, physiological, biographical, and motivational dimensions and how these characteristics relate to an individual's ability to accomplish tasks associated with the operation, maintenance and support of the weapons system.

2. Responsibilities.

A key Government role in the Materiel Acquisition Process is to articulate MANPRINT needs to industry. One of the key documents in doing this is the target audience description. It is TRADOC's responsibility to prepare the description of the target audience and AMC's to provide it in the RFP. Target audience information can be obtained through queries of the TAPA data base. Information regarding DA civilians and military personnel is readily accessible.

3. Preparation.

The contents of the target audience description depends on the range of system performance requirements of the specific weapons system. The target audience description is used by industry to make design decisions to meet the government performance requirements. Therefore, the data provided by the government should reflect the range of characteristics of the pool of soldiers and civilians on all relevant variables.

The total list of variables is dependent on the total list of tasks that the target population is expected to perform to operate, maintain and support the weapons system. The first step in determining the complete list of relevant variables to be included in the target audience description should be the consideration of those tasks and how soldier/civilian characteristics might determine design characteristics. For example, in designing a shoulder fired weapon, the design engineer must know if all of the soldiers in the target MOS have 20/20 vision. If not, will the weapon system have to compensate for the variation in soldiers' eye sight? If so, will this affect the weight of the system? Since the system is carried by the soldier, will the additional weight place too great a carrying load on the soldier? The government should specify how much weight the soldier can carry, and how much weight the soldier is currently carrying prior to the introduction of this new task.

At a minimum the target audience description should include the following:

- Current and projected force structure
- MOS/Civilian designations and descriptions to include special requirements such as security clearances
- Anthropometric description of population
- Physical description of population
- Aptitude description of population
- Biographical information
- Skills and knowledge trained
- Task performance information

a. Current and Projected Force Structure

The numbers of individuals in the Army population will operate, maintain and support the weapons system by skill level and experience should be provided in this paragraph. The current and projected force structure can be extracted from the MILPERCEN Force Management Book.

b. MOS/Civilian Designation and Description

Generic MOS descriptions can be extracted from AR 611-201, generic officer descriptions can be extracted from AR 611-101 and 611-112. Generic civilian classification descriptions can be extracted from OPM "Handbook of Occupational Groups and Series of Classes." This information will give the contractor the general information about the jobs performed in the specialty, the entry level characteristics and special information, such as security clearance requirements. The contractor will have to identify the specific tasks that are expected to be performed in operating, maintaining and supporting the new weapons system.

c. Anthropometric Description of the Population

Anthropometric data on the relevant target population should be provided on the most relevant dimensions and should include the range of physical dimensions, not just the mean value of the population. A good starting point for finding this information is the U.S. Army Human Engineering Laboratory.

d. Physical Qualifications of the Population

The PULHES and MEPSCAT profile of the population should be provided giving the range of scores. PULHES refers to the broad physical demands of an MOS and the physical ability required of an individual to perform within an MOS. The letters stand for Physical capacity or stamina, Upper extremities, Lower extremities, Hearing and ear, Eyes and Psychiatric. MEPSCAT is the Military Entrance Physical Strength Capacity Test. It assesses an applicant's physical strength capacity with the purpose of matching their capacity to the job in which they are being enlisted. MOS are clustered into 5 strength categories. A description of the range of

physical abilities on such variables as color vision, lifting, and carrying ability should also be provided. Special attention should be paid to differences in male and female scores.

e. Aptitude Description of the Population

The aptitude area requirements for each specialty should be described with an explanation of what the test scores mean. In addition, the education level, reading grade level, and other measures such as psychomotor ability should be described if available and applicable. In all cases the range of scores within the population should be provided.

f. Biographical Information

Information such as the percentage of high school graduates in the population, percentage of individuals processing English as a second language, and special interests and/or abilities of the population should be provided if relevant. Special abilities might include information on the population's familiarity with the metric system or computers.

g. Skills and Knowledges Trained

A list of the tasks trained in formal institutions as well as those trained on the job should be included. Reference should be made to TRADOC documents where appropriate.

h. Task Performance Information

Task performance data for operator, maintainer and support tasks should be provided for the population showing how task performance relates to key characteristics of the population. For example: Are there key, critical tasks that the contractor should focus on? Should the complexity and difficulty of these tasks be reduced? This information will allow the contractor to assess if there are known task performance requirements which exceed the capabilities of the current population.

APPENDIX D

MANPRINT IN THE SOURCE SELECTION PROCESS

1. Purpose

While some of the interests included under the MANPRINT process have been addressed in source selection, MANPRINT establishes a comprehensive and integrated coverage of these issues, strengthens their linkage to the acquisition goals of the Army, and gives them greater visibility in source selection decisions. For this reason, MANPRINT must be addressed in developing the Source Selection Plan, preparing the Request for Proposal (RFP) and other requirement documents, and in extracting the MANPRINT content of proposals received from industry.

2. Responsibilities

Unless MACOM MANPRINT responsibilities are exercised properly and produce documents that effectively address the issues, MANPRINT as a major area of source selection will serve little value. The source selection process is led by the Army Materiel Command with the necessary full support of the Training and Doctrine Command. TRADOC documents, such as the O&O, ROC, SMMP, and inputs to the RFP, must set the stage and guide AMC's development of a Source Selection Plan. Finally, AMC technical responsibilities for source selection provide AMC the framework to properly organize, staff and evaluate MANPRINT as a separate major area in source selection.

3. General Approach

Decisions on how MANPRINT source selection evaluation panels will be assembled and on procedural matters once the team is assembled (e.g., the depth of analysis required and the relative weight placed on an area) are in a large measure driven by three variables. These variables are the phases of the acquisition process that the evaluation addresses, the complexity of the system under consideration, and the acquisition strategy chosen. The MANPRINT Source Selection Criteria Guide discusses in detail these variables in relation to planning for source selection: Source Selection Evaluation Board organization, staffing and organization of the MANPRINT panel, and its conduct, judgment and weighing of the MANPRINT issues.

3.1 The evaluation criteria provides comprehensive MANPRINT coverage so that no significant MANPRINT issues are overlooked. Four perspectives are addressed: management, domains, systems integration, and other environmental criteria. Tailored to the system, it will have these desired characteristics:

- Specific
- Realistic and feasible
- Desirable (i.e., relevant to needs)

- Measurable (quantifiable if possible)

3.2 Below are examples of possible criteria in each of the four perspectives. More detailed discussion and examples can be found in the MANPRINT Source Selection Criteria Guide.

Management Criteria

Adequacy of offeror's concept for developing a System MANPRINT Management Plan based on requirements in the SOW.

Evaluation of offeror's proposed MANPRINT organization, level of effort, lines of authority, visibility to top management, and potential impact on assuring MANPRINT design influence.

Adequacy of offeror's plan for tracking MANPRINT performance so that the contracting officer is informed of any actual or potential difficulty in contract-stipulated MANPRINT goals and constraints.

Domain Criteria

Offeror outlines effort to avoid using valuable manpower and proposes design changes that reduce manpower needs, yet maintain designed system performance.

Demonstrates understanding of target audience description and adequately addresses MANPRINT goals and constraints.

Estimates physical and cognitive workloads of operators and maintainers, collectively and individually, and compares to MPT constraints.

Demonstrates a plan for tracking changes in design and continuously evaluating safety impacts.

Demonstrates adequacy of trade-off analysis to ensure optimization of force design/structure and the resultant costs and manpower savings.

Identifies alternative system design solutions that analyze the impact of design variations upon MPT requirements.

Understands the impact of system design on training aids, training devices and embedded training.

Allocates functions to man, machine and software for optimum system performance.

Identifies safety hazards in all environments over life cycle and documents accepted residual risks.

Demonstrates understanding of health hazard assessment in relation to survivability and casualty assessment and impact on manpower and personnel.

System Integration Criteria

Adequacy of procedures for integrating man and machine within a system (e.g., relating engineering decisions to soldier performance and matching system functions to human attributes in task allocation.

Adequacy of procedures for relating system goals to larger goals (e.g., relating soldier performance to system performance and, in turn, to unit/force effectiveness).

Other Environmental Criteria

Does the new system, compared to its predecessors, offer more performance at the same dollar cost over the life cycle, lower dollar costs for similar performance, or appropriate increase in effectiveness for increase in cost?

The new system, compared to its predecessors, reduces soldiers vulnerability. (A response involves describing failure and recovery modes in the system and its ability to adapt to and survive in unusual and degraded conditions.)

APPENDIX E

REFERENCES

DEPARTMENT OF DEFENSE DIRECTIVES (DODD)

5000.1	Major System Acquisition
5000.3	Test and Evaluation
5000.39	Acquisition and Management of Integrated Logistics Support for Systems and Equipment
5000.40	Reliability and Maintainability
5000.43	Acquisition Streamlining

DEPARTMENT OF DEFENSE INSTRUCTIONS (DODI)

5000.2	Major System Acquisition Process
5000.36	System Safety Engineering and Management

ARMY REGULATIONS (AR)

40-10	Health Hazard Assessment Program in Support of the Army Materiel Acquisition Decision Process
70-1	System Acquisition Policy and Procedures
70-10	Test and Evaluation During Development and Acquisition of Materiel
70-61	Type Classification of Army Materiel
71-2	Basis of Issue Plan (BOIP) and Qualitative and Quantitative Personnel Requirements Information (QQPRI)
71-3	User Testing
310-3	Preparation, Coordination, and Approval of Department of the Army Publications
310-49	The Army Authorization Document System
350-35	New Equipment Training and Introduction
350-38	Training Device Policies and Procedures
385-16	System Safety Engineering and Management
570-2	Organization and Equipment Authorization Tables-Personnel

ARMY REGULATIONS (AR)

570-4	Manpower Management
601-1	Human Factors Engineering Program
602-2	Manpower and Personnel Integration (MANPRINT in Materiel Acquisition Process)
611-101	Commissioned Officer Specialty Classification System
611-112	Manual of Warrant Officer Military Occupational Specialties
611-201	Enlisted Career Management Fields and Military Occupational Specialties
700-127	Integrated Logistic Support
1000-1	Basic Policies for System Acquisition

CHIEF OF STAFF REGULATIONS (CSR)

71-3	Operational Testing and Evaluation Methodology and Procedures Guide
11-2	Research and Development Cost Guide
11-3	Investment Costs Guide for Army Materiel Systems
11-4	Operation and Support Cost Guide for Army Materiel Systems
11-5	Standards for Presentation and Documentation of Life Cycle Cost Estimates
11-15	The Army Long-Range Planning System

DEPARTMENT OF THE ARMY PAMPHLETS (PAM)

11-25	Life Cycle System Management Model for Army Systems

DEPARTMENT OF THE ARMY CIRCULARS (CIR)

600-82-2	The New Manning System

AMC REGULATIONS (AMC-R)

700-15	Integrated Logistic Support

TRADOC REGULATIONS (TRADOC-R)

351-5	Designation of Military Occupational Specialties (MOS)/Additional Skill Identifier (ASI) Proponency
700-1	Integrated Logistic Support

TRADOC PAMPHLETS

11-8	Studies and Analysis Handbook

TRADOC CIRCULARS

70-83-1	Training Device Development
351-9	Individual and Collective Training Plans

AMC - TRADOC

70-1	System Acquisition Policy and Procedures
PAM-70-2	Materiel Acquisition Handbook
PAM 70-7	Nondevelopment Item (NDI) Acquisition

MOU, dtd 15 MAR 84, Integrated Logistic Support

FIELD MANUALS (FM)

22-9	Soldier Performance in Continuous Operations
101-10-1	Staff Officer's Field Manual, Organizational, Technical and Logistical Data

MILITARY STANDARDS (MIL-STD)

882B	System Safety Program Requirements
1379-3	Contract Training Programs
1388-1A	Logistics Support Analysis
1388-2A	Logistics Support Analysis Record
1472C	Human Engineering Design Criteria for Military Systems, Equipment and Facilities
1474B	Noise Limits for Army Materiel

MILITARY SPECIFICATIONS

T-23991	Training Devices, Military, General Specifications for
H-46855	Human Engineering Requirements for Military Systems, Equipment and Facilities

MILITARY HANDBOOKS

DOD-HDBK-743	Anthropometry of U.S. Military Personnel
MIL-HDBK-759	Human Factors Engineering Design for Army Materiel

MANPRINT-RELATED AUTHORIZED DATA ITEM DESCRIPTIONS

A. MANPOWER

Number	Title
DIS-HFAC-80243	Personnel Planning Report
DI-ILSS-80077	Manpower, Personnel and Training Analysis Report
DI-ILSS-80114	Logistic Support Analysis Record (LSAR) Data

B. PERSONNEL

Number	Title
DI-H-1300	Personnel and Training Requirements
DI-H-7059	Human Engineering Test Report
DI-H-7068	Task and Skill Analysis Report
DI-H-7091	Personnel Performance Profiles
DI-H-25713B	Task Listings Report
DI-H-33059	Qualitative and Quantitative Personnel Information
DI-HFAC-80243	Personnel Planning Report
DI-ILSS-80078	Personnel Performance Profiles
DI-ILSS-80115	LSA-015, Sequential Task Description Report

C. TRAINING

Number	Title
DI-H-1300	Personnel and Training Requirements
DI-H-10010	Common Training Analysis Base
DI-H-7066	Training and Training Equipment Plan
DI-H-7067	Training Course Proposal
DI-H-7069	Training Course/Curriculum Outlines
DI-H-7072	Audio Aids, Master Reproducibles and Review Copies for Training Equipment and Training Courses
DI-H-7076	Instructor's Utilization Handbook for Simulation Equipment

Number	Title
DI-H-25711B	Training Development and Support Plan Report
DI-H-25713B	Task Listings Report
DI-H-25718B	Trainer Functional Description Report
DI-H-25721B	Training Support Requirements Report
DI-H-25724B	Student Training Materials
DI-H-25728B	Instructor Training Course Materials
DI-H-25774B	Training Program Work Report
DI-ILSS-80047	Training Court Standards
DI-ILSS-80076	Training Program and Training Equipment Plan
DI-ILSS-80077	Manpower, Personnel and Training Analysis Report
DI-ILSS-80084	Training Material Outline
DI-ILSS-80143	Training Plan

D. HUMAN FACTORS ENGINEERING

Number	Title
DI-H-7051	Human Engineering Program Plan
DI-H-7052	Human Engineering Dynamic Simulation Plan
DI-H-7053	Human Engineering Test Plan
DI-H-7054	Human Engineering System Analysis Report
DI-H-7055	Critical Task Analysis Report
DI-H-7056	Human Engineering Design Approach Document--Operate
DI-H-7057	Human Engineering Design Approach Document--Maintainer
DI-H-7058	Human Engineering Test Report
DI-H-7059	Human Engineering Progress Report
DI-HFAC-80241	Human Factors Technical Report
DI-HFAC-80242	Human Factors Design Analysis Report
UDI-H-20002A	Report, Design Review

E. SYSTEM SAFETY

Number	Title
DI-H-1321B	Explosive Hazard Classification Data
DI-H-1329A	Accident/Incident Report
DI-H-1336	Noise Measurement Report
DI-H-7047	System Safety Program Plan
DI-S-1838	Standard Operating Procedures for Hazardous Materials
DI-SAFT-80100	System Safety Program Plan
DI-SAFT-80101	System Safety Hazard Analysis Report
DI-SAFT-80102	Safety Assessment Report
DI-SAFT-80103	Engineering Change Proposal System Safety Report
DI-SAFT-80104	Waiver or Deviation System Safety Report
DI-SAFT-80105	System Safety Program Progress Report

F. HEALTH HAZARDS

Number	Title
DI-SAFT-80106	Occupational Health Hazard Assessment
DI-MISC-80123	Medical and Health Plan

OTHER

ALTMAN, James W., et. al. Human Engineering Guide to Equipment Design. Washington: U.S. Govt. Printing Office, 1963

MEISTER, David. Behavioral Analysis and Measurement Methods. John Wiley & Sons, Inc., 1985.

WOODSON, Wesley E. Human Factor Design Handbook. McGraw Hill Book Co., 1984.

APPENDIX F

MANPRINT ACTIVITIES DURING THE MATERIEL LIFE CYCLE

1. INTRODUCTION

This appendix focuses on the MANPRINT activities that will take place as a system progresses through its acquisition life cycle. The appendix has been written to reflect the traditional life cycle system management model and can be tailored to fit the Army's Streamlined Acquisition Process (ASAP). The roles and responsibilities of the four main players: Combat Developer, Training Developer, Materiel Developer, and Industry are shown in detail. Specific timelines for each of the activities can be found in TRADOC's MANPRINT "Cook Book" dated 20 August 1986.

2. PRE-PROGRAM INITIATION PHASE (REQUIREMENTS AND TECH BASE)

2.1 Combat Developer

a. Identifies and locates documents and data required to develop MANPRINT goals and constraints.

b. Establishes a MANPRINT Joint Working Group (MJWG) with representation from the proponent school, Army Materiel Command (AMC), Human Engineering Laboratory (HEL), Army Research Institute (ARI), the Surgeon General's Office (TSG), test agencies and integrating centers.

c. Develops initial total system performance standards based on requirements needed to resolve battlefield deficiencies identified through the Mission Area Analysis (MAA) and other studies.

d. Reviews the Mission Area Materiel Plan (MAMP) developed by the Materiel Developer which identifies emerging technologies and technology base opportunities.

e. Initiates SMMP preparation prior to or concurrently with the decision to draft an Operational & Organizational (O&O) Plan.

f. If the SMMP calls for a HARDMAN analysis, conducts pre-contract activities to include developing a Statement of Work (SOW). Prepares a request for a HARDMAN to HQ, TRADOC. Assigns a Contracting Officer's Representative (COR) if a HARDMAN analysis is approved.

g. Conducts an Early Comparability Analysis (ECA), if required, with support from the Training Developer.

h. Inputs MANPRINT goals and constraints into the O&O Plan/Mission-Need Statement (MNS). MANPRINT goals and constraints are derived from input provided by the MJWG and are contained in the SMMP.

i. Develops the Target Audience Description (see Appendix E) with the input provided by the Training Developer, ARI, and AMC.

j. Identifies initial MANPRINT evaluation issues and criteria during the development of the O&O Plan/MNS and the SMMP. Issues can be addressed by analysis, observation, survey, simulation, modeling or testing. Provides evaluation issues and criteria to the materiel developer for incorporation into the Test and Evaluation Master Plan (TEMP).

k. Insures MANPRINT is addressed during the preparation for the Cost and Operational Effectiveness Analysis (COEA).

l. Provides ECA results to the Materiel Developer for inclusion in the Logistic Support Analysis (LSA).

m. Programs and requests for funds required to support the analyses identified in the SMMP.

2.2 Training Developer

a. Develops training goals and constraints from guidance, lessons learned, MAA, Post Fielding Training Effectiveness Analysis (PFTEA) or a completed ECA.

b. Inputs training goals and constraints to SMMP and in turn to the O&O Plan/MNS. These training goals and constraints serve as the basis for developing the System Training Plan (STRAP).

c. Develops the training strategy and initiates the STRAP to document the training concept and plans for development of training courses, training support products and training facilities.

d. Develops estimates of training needs. Includes this data in the STRAP and holds as input for the Required Operational Capability (ROC). Estimates will include consideration of system training device needs.

e. Develops evaluation issues and criteria for training. Provides issues to the Materiel Developer for inclusion in the TEMP.

f. Participates in the MJWG.

g. Provides ECA training input to the Combat Developer.

2.3 Materiel Developer

a. Interjects MANPRINT concerns into tech base and exploratory development efforts.

b. As a member of the MJWG participates in the SMMP development and assists the Combat Developer in identifying MANPRINT goals and constraints for the O&O Plan/MNS.

c. Establishes the Test Integration Work Group (TIWG) to initiate TEMP preparation upon receipt of the draft O&O Plan.

2.4 Tester

a. Serves as a member of the MJWG.

b. Joins the TIWG when established by Materiel Developer.

c. Participates in developing the TEMP and contributes to the planning of future tests and evaluations.

2.5 Evaluator

a. Develops or reviews MANPRINT evaluation issues and criteria for inclusion in the TEMP and Independent Evaluation Plans (IEP)s. Uses the SMMP to assure that evaluation issues and criteria reflect requirements.

2.6 Industry

a. Provides comments during the circulation of the draft O&O Plan/MNS.

b. Assists the MJWG with contract support for tasks and analyses identified in the SMMP.

3. CONCEPT EXPLORATION PHASE (REQUIREMENT AND TECH BASE ACTIVITIES)

3.1 Combat Developer

a. Updates the SMMP.

b. Insures the MANPRINT is addressed in the COEA as new data becomes available.

c. Provides updated evaluation issues and criteria to the Materiel Developer for inclusion in the TEMP.

d. Provides ECA results to the Materiel Developer for use in the LSA.

e. Initiates the Required Operational Capability (ROC). The Combat Developer will use input provided by the MJWG to develop the MANPRINT Assessment (paragraph 8) of the ROC.

f. Inputs MANPRINT issues to the Integrated Logistics Support Plan (ILSP).

g. If a HARDMAN analysis is planned, provides the Contracting Officer Representative (COR). The HARDMAN analysis will be contracted through the TRADOC Soldier Support Center (SSC).

h. Assists the Materiel Developer in the development of the MANPRINT section of the SOW and in the development of MANPRINT source selection evaluation criteria.

3.2 Training Developer

a. Continues the development of training evaluation issues and criteria to support development of the STRAP.

b. Provides training evaluation issues and criteria to the Materiel Developer for inclusion in the TEMP.

c. Provides the training assessment paragraph for the draft ROC to identify need for New Equipment Training (NET), institutional training, extension and sustainment training. Identifies the requirement for embedded training, training devices and training aids.

d. Provides the system training device annex for the ROC.

e. Provides training and training device input to the ILSP.

3.3 Materiel Developer

a. Updates the TEMP.

b. Translates MANPRINT goals and constraints provided by the Combat and Training Developer into contractual terms through the Statement of Work (SOW).

c. Issues a data call to the Combat and Training Developer to obtain data needs. Procedures are

outlined the AMC/TRADOC ILS Memorandum of Understanding dated March 1984.

d. Assists the Combat Developer with the preparation of the ROC.

e. Initiates Program Management Documents (PMD)s and ensures MANPRINT input is included. PMDs are discussed in detail in Paragraph 5.8 of this chapter.

f. Initiates the Integrated Logistics Support Plan (ILSP).

g. Ensures that a Human Factors Engineering Analysis (HFEA), a Health Hazards Analysis (HHA), and a Safety Assessment Report (SAR) are conducted.

3.4 Tester

a. Continues activities outlined in Pre-Program Initiation.

b. Develops the Outline Test Plan (OTP) with sufficient personnel, instrumentation and range resource planned support to address MANPRINT evaluation issues and criteria identified in the TEMP.

c. Requests test players based on requirements outlined in the Target Audience Description.

3.5 Evaluator

a. Continues activities outlined in Pre-Program Initiation.

b. Includes MANPRINT evaluation issues and criteria provided by the Combat and Training Developers in the IEP.

3.6 Industry

a. Structures analyses and provides documentation to support system concept selection.

b. Initiates its own contractor MANPRINT program.

4. DEMONSTRATION AND VALIDATION PHASE (PROOF OF PRINCIPLE)

4.1 Combat Developer

a. Updates the SMMP.

b. Updates the ROC based on data obtained through planned MANPRINT analyses and testing.

c. Reviews the materiel developer's Basis of Issue Plan Feeder Data (BOIPFD) and the Qualitative and Quantitative Personnel Requirements Information (QQPRI).

d. With the Material Developer, participates in preliminary design reviews.

e. Updates MANPRINT data in the ILSP.

4.2 Training Developer

a. Updates the STRAP.

b. Provides input to materiel developer's New Equipment Training Plan (NETP) and TRADOC's Doctrine and Tactics Training Plan (DTTP).

c. Reviews the BOIPFD and the QQPRI for adequacy of support and consistency with the stated training concept.

d. Develops the Test Training Support Package (TTSP) and evaluates MANPRINT evaluation issues and criteria during user testing.

4.3 Materiel Developer

a. Fixes MANPRINT responsibilities through the appointment of a Program Manager (if appropriate).

b. Updates PMDs begun in Concept Exploration.

c. Monitors technical testing for MANPRINT implications.

d. Develops the BOIPFD and the QQPRI.

e. Participates in system design reviews.

f. Monitors the contractor's performance against MANPRINT requirements delineated in the SOW.

g. Requests an updated HFEA, HHA and SAR.

4.4 Tester

a. Prepares the Test Design Plan (TDP) to resolve MANPRINT issues that have not been answered through studies or analyses.

b. Writes the Test Report (TR) following the conduct of a test.

c. Assists in updating the TEMP.

4.5 Evaluator

a. Prepares the Independent Evaluation Report (IER) using the TR as well as other analyses, studies and contractor supplied data.

b. Assist in updating the TEMP.

4.6 Industry

a. Refines analyses outlined in Concept Exploration.

b. Reviews test results to determine MANPRINT impact.

5. FULL SCALE DEVELOPMENT PHASE (DEVELOPMENT PROVE OUT)

5.1 Combat Developer

a. Updates the SMMP.

b. Arranges for a HARDMAN reiteration if required to support a milestone decision review. Coordinates funding requirements with the PM.

c. Evaluates the results of user testing for MANPRINT implications.

d. Forwards the completed BOIP and the QQPRI to HQDA for approval no later than 39 months prior to the First Unit Equipped (FUE).

e. Assists the Materiel Developer in the development of the MANPRINT section of the SOW and in the development of MANPRINT source selection evaluation criteria.

f. Assists the Materiel Developer in reviewing engineering change proposals.

g. Assists the Materiel Developer in the ILSP update.

5.2 Training Developer

a. Assists the Materiel Developer in monitoring contractor training for instructors and key personnel to support user testing.

b. Updates the STRAP based on test results and additional guidance.

c. Updates the DTTP and assists the Materiel Developer in updating the NETP.

5.3 Materiel Developer

a. Updates the PMDs as described for earlier phases.

b. Monitors the contractor's compliance with MANPRINT terms of the contract as described in previous phases.

c. With the Combat Developer, reviews engineering change proposals for MANPRINT implications.

d. Updates the ILSP.

5.4 Tester

a. Performs activities as described in Demonstration and Validation.

5.5 Evaluator

a. Performs activities as described in Demonstration and Validation.

5.6 Industry

a. Reviews test results for MANPRINT implications to ensure the system is ready to proceed into the Production and Development Phase.

b. Continues tracking progress at achieving MANPRINT goals and objectives using actual data collected.

6. PRODUCTION AND DEPLOYMENT PHASE

6.1 Combat Developer

a. Updates the SMMP if a Follow-on Test and Evaluation (FOT&E) is required.

b. Conducts a post fielding Early Comparability Analysis (ECA) to assess the actual effectiveness of MANPRINT in meeting its goals and constraints and to provide a basis for inserting MANPRINT into future systems or product improvements.

c. Assists the Materiel Developer with the assessment of the MANPRINT efforts.

6.2 Training Developer

a. Develops a Program of Instruction (POI) for each course planned in the STRAP for each MOS.

b. Together with Materiel Developer, executes the responsibilities as outlined in the NETP.

c. Conducts post fielding evaluations including a Post Fielding Training Effectiveness Analysis (PFTEA), if required.

d. Validates the planned unit level sustainment training through proponent school on-site evaluations.

6.3 Materiel Developer

a. Conducts NETP.

b. Through sample data collection, deficiency reports and readiness reports, assesses the effect of the MANPRINT effort.

c. Reviews engineering change proposals to ensure that MANPRINT implications have been considered in the decision process.

6.4 Tester

a. Performs activities as described in Demonstration Validation if a FOT&E required.

b. Performs production qualification testing using samples selected from the first production lot.

6.5 Evaluators

a. Performs activities described in Demonstration and Validation.

6.6 Industry

a. Monitors actual production to ensure that MANPRINT contractual requirements are being met.

b. Evaluates the impact of design changes on established MANPRINT performance objectives.

7. MANPRINT ACTIVITIES IN NDI

7.1 If a system is selected through the NDI process, MANPRINT activities will be tailored to fit the NDI situation. Activities include:

a. Formation of a MJWG and the development of a SMMP for the NDI system.

b. Development of an IEP that contains MANPRINT evaluation issues and criteria that must be addressed.

c. Conduct of a market investigation using the evaluation issues and criteria contained in the IEP with Material Developer, Combat Developer, and logistician representation.

d. Testing of the NDI item if insufficient data exists or if the system will be operated in a new environment.

e. Insertion of MANPRINT goals and constraints into the NDI ROC.

f. Meeting of MANPRINT goals and constraints in the QQPRI and the BOIP. Reaction time will be accelerated because of the shorter NDI acquisition cycle.

g. Input of MANPRINT goals in the NDI Acquisition Strategy (AS), Acquisition Plan (AP), Integrated Logistics Support Plan (ILSP).

7.2 The MJWG must recognize some of the special challenges for MANPRINT consideration in an NDI acquisition:

a. Some health hazards and safety deficiencies, not normally accepted in Army hardware, may be acceptable, or controlled by procedural safeguards.

b. Contractor logistics support may be provided for a period of time before the Army system takes over.

c. The ILS activities will be accelerated.

APPENDIX G

MANPRINT DOMAINS - ISSUES AND CONCERNS

1. Introduction to Interrelationships Between Domains

MANPRINT enhances human performance and reliability through the integration of the six domains (Manpower, Personnel, Training, Human Factors, System Safety and Health Hazard) throughout the system acquisition process. The quantitative or qualitative altering of one MANPRINT element may have substantive ripple effects across the others. Several examples follow:

a. If less capable soldiers are available for the system tasks, these soldiers may require more training time to reach the same level of proficiency as soldiers with greater capabilities;

b. If training time is extended, fewer soldiers will be available for assignment to operate and maintain the fielded systems;

c. If the training capacity is overtaxed and new students cannot be accommodated, recruiting goals will be affected;

d. Personnel policies, including career progression, retention, etc., will affect personnel performance and reliability, as well as training requirements;

e. Soldier performance and reliability are directly related to system design and the environment in which the soldier works; and

f. System performance is affected by soldier workload, which may vary based on the number of soldiers, quality of soldiers, their training, system design and the environment.

If human factors engineering is not optimized in design, all of the other domains could be affected rather drastically. For example, if a truck without a cargo handling device is assigned the function of transporting ammunition, it is obvious that additional manpower will be needed to physically load and off-load the ammunition. In fact, the ability to influence manpower and personnel for a system may not be directly influenced by the design of the principle item, but, rather, by the associated support equipment that is developed separately. In the ammunition example, in addition to integral material handling equipment on trucks, the Army is seeking to introduce dramatically improved material handling equipment such as the Shooting Boom Forklift in a specific attempt to reduce both manpower and the physical burden on soldiers. For the future, the Army is investigating and developing robotic systems to

meet threat scenarios and to reduce MPT demands. This example is provided to illustrate the far ranging interrelationships that must be considered in optimizing total system performance.

For one aviation system, it was found that MPT requirements for peculiar ground support equipment and test measurement and diagnostic equipment were not identified before initial operational capability. The consequences were reflected in increased maintenance down time, excessive use of spare parts, and reduced availability. This example stresses the need for total system consideration in each of the doma' ..

In the training area it is critical that every effort be made to field required trainin~ devices in time to provide trained operators and maintain s for early fielding. This point is best illustrated in the aviation area. In one specific case, because of the delay in fielding a flight simulator, the impact was stated in terms that if operating costs continued escalating rapidly, the Army would have to curtail a part of the flying-hour program. The flying-hour program consists of two parts: mission dollars and training dollars. Since the mission is the only reason for the unit's existence, it was apparent that the training dollars would be reduced to a minimum to support the mission. This translates into less proficient pilots, since these same missions do not necessarily include all those tasks a pilot needs to practice to remain proficient in the aircraft.

The human factors engineering domain influences system safety/health hazards in fundamental ways. Attention to HFE translates into designing system safety features (safety devices, warning devices, dials, knobs and workspace). Without attention to HFE, a common condition known as "design drift" will occur. An example is the cockpit that was originally designed to accommodate the crew in a safe environment. However, as design proceeded, additional equipment had to be added at the expense of the cockpit space. The final result was not only potential safety problems, but a degradation in human performance. Health hazards, too, are often the result of inattention to HFE concerns.

2. Manpower

Manpower management focuses on the determination of essential human resource requirements; which requirements will be supported with authorizations (i.e., affordable); and what the personnel demands associated with those authorizations will be by grade and skill. The manpower and personnel domains interface and overlap at many points. The difference being that manpower deals with defining the human resource demand ("spaces") while personnel focuses on supporting this demand through the acquisition, training and assignment of people ("faces").

During system development, the concern in the manpower domain is to determine the system's impact on Army manpower

resources and to assure each system is optimized from a manpower viewpoint. The force structure implications of the system must be identified. Appropriate goals and constraints regarding the system's human resource demand should be established in terms of affordability and supportability. Early in the development process, based on force structure and organizational design guidance provided, a manpower "footprint" into which the prospective system must fit is determined.

The contractor will be furnished this force structure "footprint" in terms of manpower goals and constraints. The contractor will be required to demonstrate that these stipulated goals and constraints have not been breached by the system design. He must also demonstrate that the desired total system performance can be achieved with the desired manpower requirement. This will require the contractor to consider manpower in the basic design decisions that will impact on task, workload, function allocation between the man, man-machine and machine, and the operational environment projected for the system. Figure G-1 depicts a manpower estimation process. Tasks considered must include not only those directly related to the equipment but also the off-equipment tasks that the soldier performs, e.g., navigate. The operational environment, possibly requiring continuous operations, stress, or extreme climatic conditions, must also be included. Resulting manpower requirements are measured in terms of soldier performance which allows total system performance to meet the required criteria.

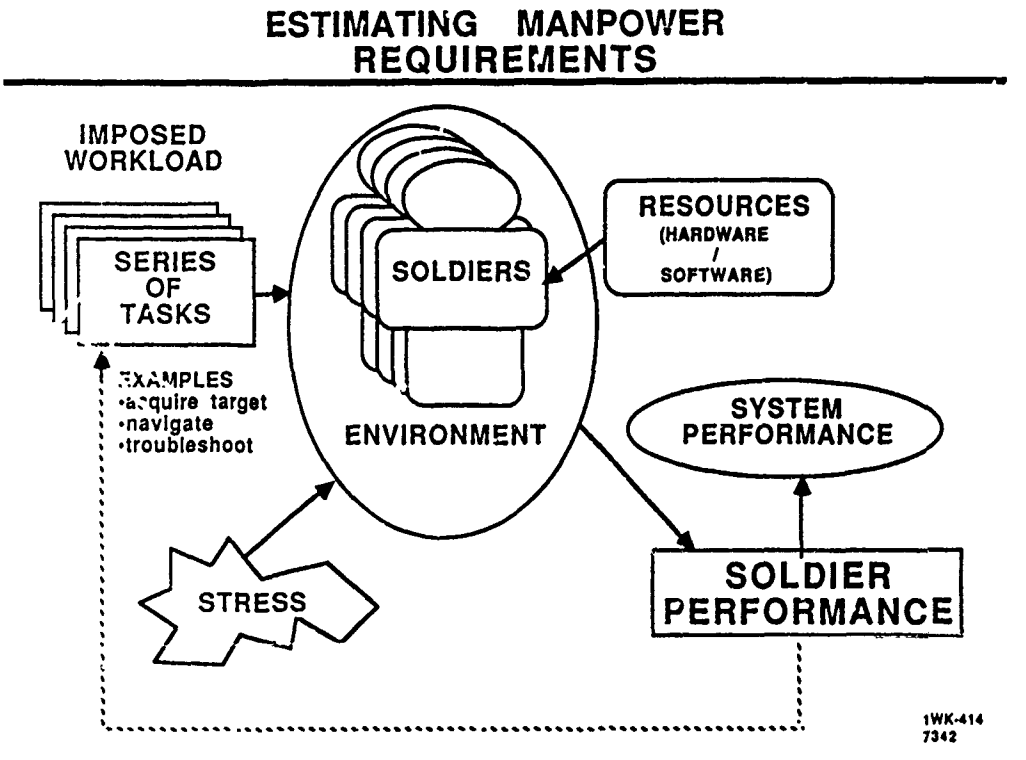


Figure G-1. Estimating Manpower Requirements

The system's manpower requirement will be defined during the development process in the BOIP Feeder Data (BIOPFD) initiated by the materiel developer. The BOIPFD will be accompanied by the Quantitative and Qualitative Personnel Requirements Information (QQPRI) which defines proposed MOSs and workload. The materiel developer uses this information as input for concept studies, life-cycle cost estimates, and trade-off analysis during the research and development process. These are forwarded to TRADOC for formal development of the BOIP and update of the QQPRI, during which training impacts and any proposed MOS decisions are developed. The BOIP and QQPRI, when approved, will be the basis for any modification to existing organizational structure and be reflected in a new TOE.

Maintaining manpower requirements within the force structure guidance provided is critical to system development. If increases beyond guidance are required, the affordability of these increases will be determined through the Total Army Analysis (TAA) and programming functions to ensure overall Army end-strength constraints are met. This could create a situation in which the system's manpower requirements are not fully supported by authorizations. This decreased level of manning may degrade actual system performance achieved after fielding to below the level desired. Since early system design decisions will dictate the resulting manpower requirement, early-on manpower analysis and trade-offs are necessary to prevent unanticipated, or unsupportable demands made at system fielding.

Other manpower issues to be considered in design include continuous/sustained operations, casualty estimation, anticipated levels of authorization and manning and the resiliency required on the battlefield to maintain performance. (See Figure G-2)

WHAT DRIVES MANPOWER?

How do you account for:

- **Continuous/Sustained Operations**
  - **Task complexity or Ambiguity**
  - **State of arousal**
  - **Level of training (Up to a point)**
- **Casualties**
  - **staff officers guide (FM 101-10-1, chapter 5, section III)**
  - **what are the estimates**
- **Level of manning**
  - **required**
  - **authorized and ALO**
  - **operating strength**
- **Necessary resiliency**
  - **can 4 man tank crew operate with 3 men?**
  - **Is performance seriously degraded?**

What does an engineer design for?

Inadequate Numbers Will Degrade Performance

Figure G-2. What Drives Manpower

3. Personnel

As indicated above, the manpower process will identify the number of soldiers required and authorized. These authorizations will be defined in terms of MOS and skill level (grade) in The Army Authorization Documents System (TAADS). The personnel community must then acquire and assign properly trained, qualified people to fill these established authorizations.

During system development an objective of MANPRINT is to obtain a match between the system requirements and the characteristics of the individual soldiers and crews who will operate and maintain the system. It must be recognized that individuals vary across many dimensions, including their cognitive, physical, psychomotor skills and their background and experience. (See Figure G-3.)

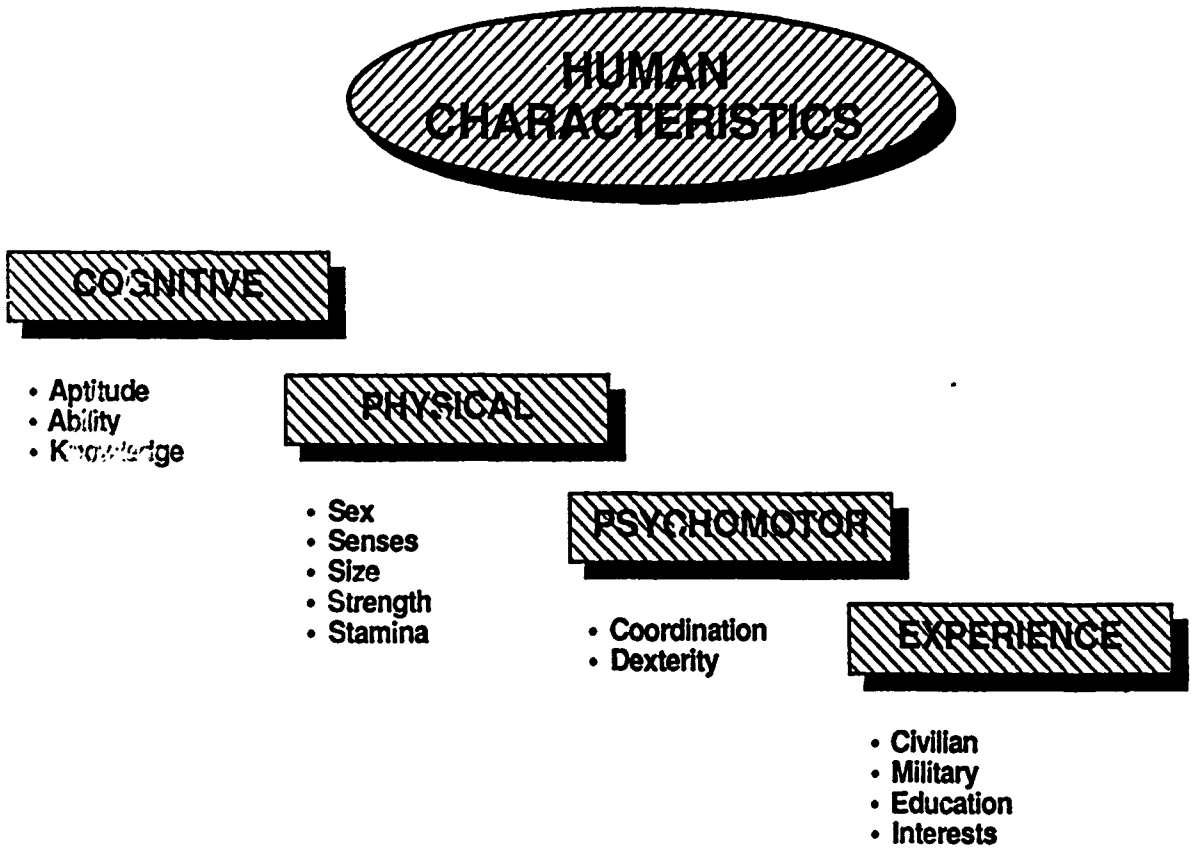


Figure G-3. Personnel Characteristics

The primary measurement tool employed by the Army to quantify soldier characteristics is the Armed Services Vocational Aptitude Battery (ASVAB), from which Armed Forces Qualification Test (AFQT) scores and Aptitude Area (AA) scores are derived. These scores are used to establish recruiting quality goals and minimum MOS entrance requirements.

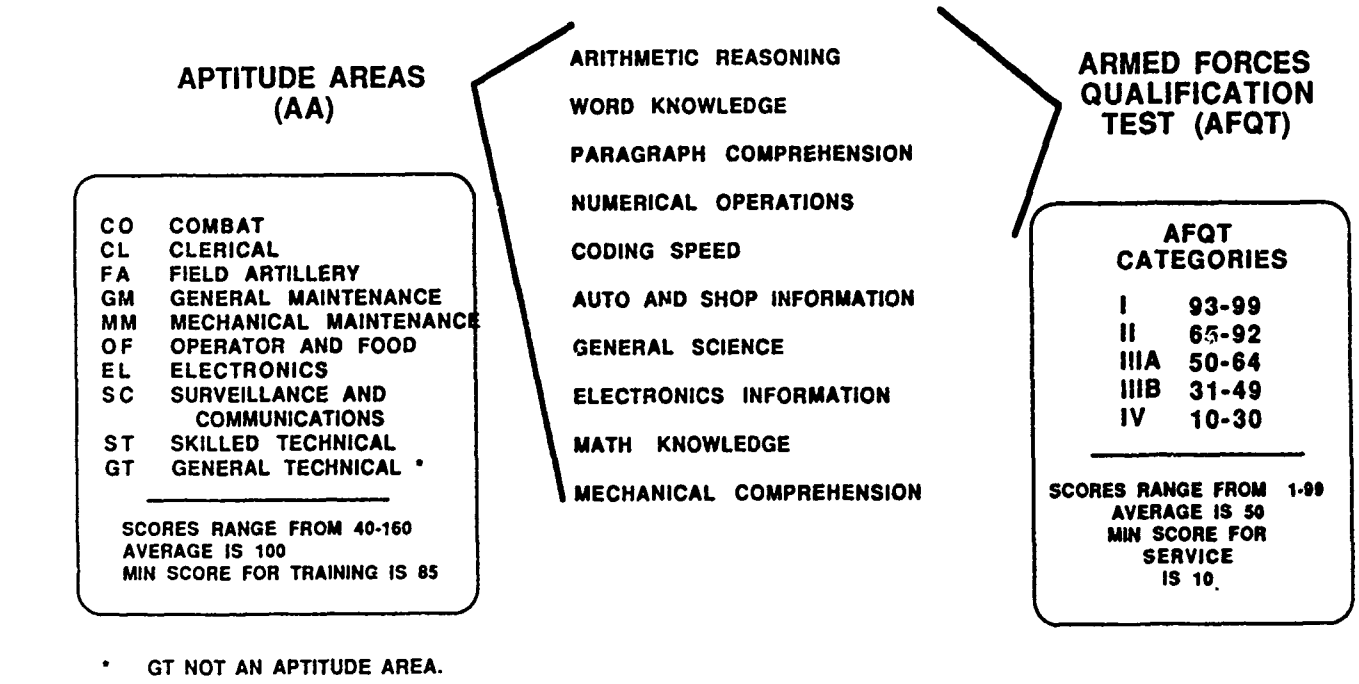


Figure G-4. Armed Services Vocational Aptitude Battery Test

The Military Entrance Physical Strength Capacity Test (MEPSCAT) is used to assess an applicant's physical strength capacity in order to match this capacity with an enlistment MOS for which the individual is qualified. The physical profile (PULHES) matches physical capabilities with others required to perform in the MOS. The majority of a MOS's entrance requirements are documented in AR 611-201.

Since the Army almost exclusively relies on initial entry accessions to man the force, the type of individual that will be available for a system can be described by looking at the current force and projected recruiting information. It is important that the Army provide contractors with information

relative to its soldiers so that they may be considered in the system design process. The vehicle in which the range of all appropriate individual characteristics are defined is the Target Audience Description (TAD). Using input from the TAD, equipment can be designed to achieve required performance criteria with the type of soldier who will be available to operate or maintain the system when it is fielded. This would reverse the existing trend in which equipment has demanded higher than existing soldier ability (especially cognitive ability) in order to produce satisfactory system performance. Figure G-5 shows, in terms of AFQT categories, that the current quality requirement already exceeds current inventory. The projected requirement further increases this mismatch of requirement to inventory.

CURRENT FORCE QUALITY AND REQUIREMENTS

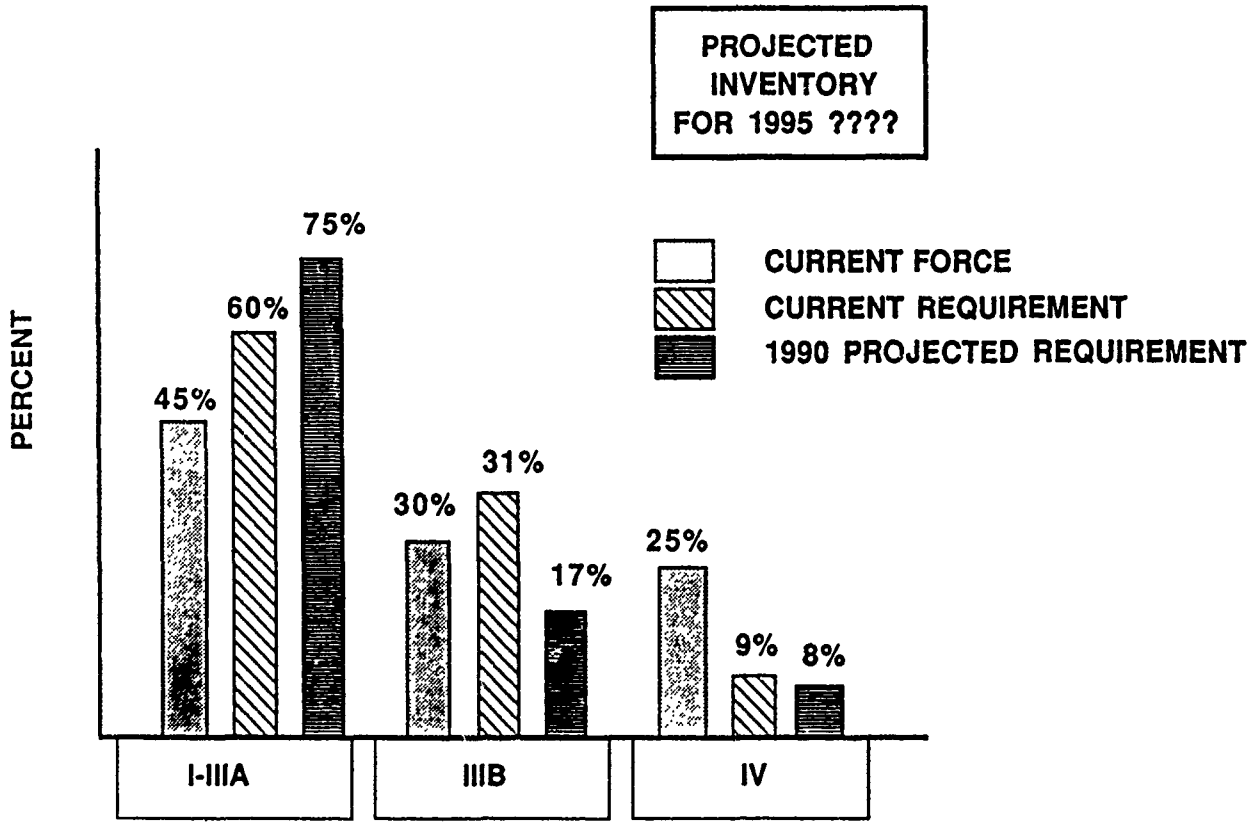


Figure G-5. Current Force Quality and Requirements

The personnel domain must be concerned with the quality of individuals required by a new system. The Army is in recruiting competition with the other Armed Services, private industry and institutions of higher learning. The number of

quality individuals that can be recruited each year is limited and very costly. These quality individuals, as defined by AFQT, AA scores and education, must be distributed across all MOSs that make up the Army's force to ensure combat effectiveness in all areas. The aggregate demand for quality must stay in line with what is available. Each new system must be kept within established quality requirement constraints. If not, either a disproportionate distribution of quality or a manning shortfall will result.

In addition to quality demands, other personnel aspects should be considered with regard to the system.

-- Certain MOSs are historically hard to recruit, hard to retain people in, difficult to train for and suffer distribution problems. Increasing the requirements for these problem MOSs should be avoided if at all possible.

-- Part of the allowable end strength is always in the Trainee, Transient, Holdee and Student (TTHS) account. Soldiers in this overhead account are not available for assignment against force structure authorizations. The biggest factor in the size of the TTHS is length of initial entry training. Increases in the amount of training for an MOS directly increase the number of soldiers in the TTHS which increases the number that must be recruited in order to fill existing authorizations. Even though no increased manpower authorizations occur, an increased personnel burden is created. With a declining end strength, increases in one MOS will cause an equal decrease to occur in another MOS. For this reason, any increases in training requirements should be minimized if possible.

-- Promotion within an MOS is directly affected by the grade structure of the MOS. Changes in a MOS which skew its Standards of Grade Authorizations (SGA) may have a significant impact on promotion opportunities. Unconstrained demands for higher grade personnel cannot be allowed.

-- The New Manning System has a goal of unit replacement rather than individual replacement. This new system, including regimental affiliation and COHORT training and personnel fill, has the potential to enhance unit performance and reduce workload through cohesive bonding of the unit. Fielding by the New Manning System should be considered.

4. Training

In the most basic terms, training is the process which prepares soldiers to do jobs. The soldier is given a series of tasks, aptly named soldier tasks, "which describe what the Army wants the soldier to do." Performance standards are established to define how well the Army wants the soldier to do the task; and finally, performance reflects the soldier's ability to accomplish the desired tasks.

When it acquires a materiel system, the Army acquires with it a training system. As a MANPRINT concern, training goals and constraints must affect system design in a positive way. Traditionally, system designers have not been constrained by the Army's training resources. The training community generally faced a completed system design and was asked to structure a training concept that would accommodate the operational and maintenance needs of that design.

The startpoint for training is to develop the training strategy--who, where, what and when.

TRAINING STRATEGY & CONCEPT

TRAINING STRATEGY

- Who is to be trained – active, reserve, civilian
- What is to be trained – system specific and combat critical tasks
- When is the training to take place – BT, AIT, NCOES
- Where is the training to take place – institution or unit

TRAINING CONCEPT

- How should the training be conducted – on-equipment, embedded, training device, or simulator

PLUS

- Sustainment training requirement
- Resource contraints

GOAL: Make the acquisition process responsive to training constraints.

Figure G-6. Training Strategy and Concept

As indicated in Figure G-6, the "who" is defined in the Target Audience Description; "where" will be governed by considerations of training transfer and the impact on the operating strength of the MOS; "what" should include all equipment-related and other soldier tasks; and "when" will be governed by consideration of timing and skill decay. The training concept then defines how the training will be accomplished by considering training delivery options such as embedded training, training devices and resources. Potential resource considerations are listed in Figure G-7.

TRAINING RESOURCES

- LOGISTICS
  - CLASS III & V
- SOLDIER TIME
  - INSTITUTIONAL AND UNIT BURDEN
- FACILITIES
  - RANGES
- HOURS
  - FLYING HOURS
- DOLLARS
  - COST OF TRAINING A SOLDIER
- EQUIPMENT AND DEVICES
- TRAINING TECHNOLOGY
  - COMPUTER BASED TRAINING

ARE RESOURCES A CONSTRAINT?

Figure G-7. Training Resources

The training strategy and concept (which includes resource consideration) become the basis for developing training goals and constraints. Figure G-8 shows the training design process in parallel to the equipment design process. By providing training goals and constraints at the start, training strategy and concept will be considered during function allocation. During Tradeoff Analysis, cost, performance and supportability also will be considered. In the process, design decisions will be affected by training considerations.

TRAINING & ENGINEERING INTERACTION

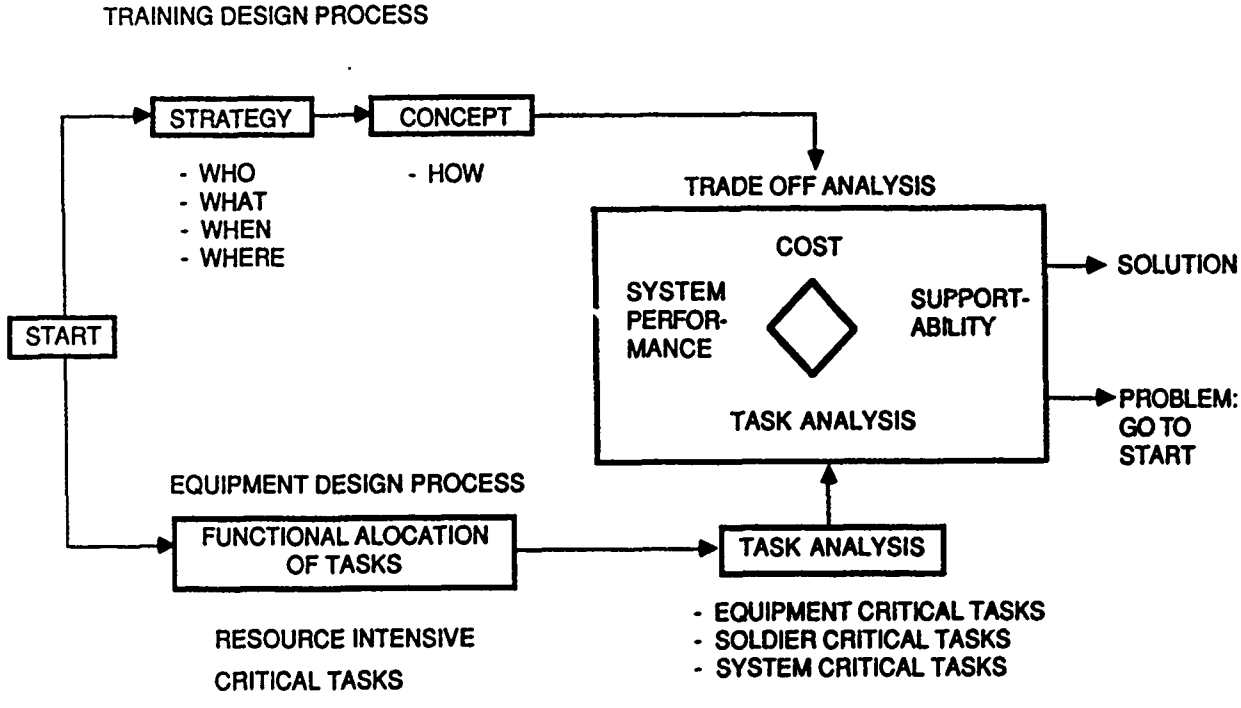


Figure G-8. Training Design Process

Some important training issues and concerns include:

a. Training time is finite.

b. Decreased time spent in school increases the number of troops in units (operating strength).

c. Training time lost to units--because of more time in schools--results in decreased readiness.

d. Training in schools should adequately prepare soldiers to do their job, i.e., most critical tasks should be trained in the school.

e. The system training strategy must meet the widely varying needs of the Army National Guard and Reserve units.

f. The results of training are not everlasting. Knowledge and skills acquired through training decay over time and with disuse. Actions should be taken to design out, if possible, tasks that may have inordinately high skill decay rates because they increase the requirements for sustainment training.

g. A soldier can only learn so many things.

h. Training generally cannot overcome poor design.

i. Training cannot always make up for soldier aptitude differences.

j. Training drivers flow from the early functional analyses conducted by contractors to allocate weapon system functions either for performance by the hardware/software system or by the soldier. The ability to extrapolate future training demands among the alternative system design approaches is critical to a cost-effective strategy.

4.1 Embedded Training

Embedded training has become an increasingly important consideration because of the tremendous capabilities of microcomputers. Embedded training is defined as training that is provided by capabilities designed to be built into or added onto operational systems to enhance and maintain the skill proficiency necessary to operate and maintain that equipment end item. Early in training concept development, decisions are made as to whether specific training should be conducted on actual equipment through embedded training or through training devices.

An embedded training capability must be thoroughly evaluated and considered as the preferred alternative among other approaches to the incorporation of training subsystems of all materiel systems. Embedded training may have the advantage of permitting training on the weapon system itself. Moreover, it will not adversely impact the operational requirements/capabilities of the system and should be identified early enough to be incorporated into initial prototype designs. It avoids delays in receipt of training materials and offers the

opportunity for more efficient and frequent training. Embedded trainers encompass four training categories:

- Category A-INDIVIDUAL/OPERATOR.

  Training objective: To attain and sustain individual, maintenance, and system orientation skills.

- Category B-CREW

  Training objective: To sustain combat ready crews/teams. This category builds on skills acquired from Category A.

- Category C-FUNCTIONAL

  Training objective: To train or sustain commanders, staffs, and crews/teams within each functional area to be utilized in their operational role.

- Category D-FORCE LEVEL (Combined Arms Command and Battle Staff)

  Training objective: To train or sustain combat-ready commanders and battle staffs utilizing the operational system in its combat operational role.

Requirements and resources for training must be factored by the system's proponent in concept formulation of the end item/system and pursued throughout the materiel acquisition process. A training strategy, to include the consideration of embedded training, must be included in the initial requirements documents (Operational and Organizational Plan).

Integrated Logistic Support (ILS) and MANPRINT are the catalysts for factoring embedded training during the Pre-Concept Exploration and Prototyping Phase of the Life Cycle System Management Model (LCSMM). Embedded training will be addressed at all Materiel Acquisition Decision Reviews and at each milestone for all system acquisition programs through the ILS plan and System MANPRINT Management Plan. During the review, system proponents will provide a definitive training strategy with associated analysis and rationale supporting use/non-use of embedded training.

4.2 Training Devices Development

There has been an enormous growth in the need for and use of training devices and simulators to substitute for the extreme costs associated with the actual use of weapons systems and support equipment for training purposes. Training devices are either (1) System Devices - those acquired to support a specific system or (2) Non-System Devices - those acquired to

support general military training, training on more than one system or several different types of equipment. Training device requirements may be presented in any of these forms -an annex to the system ROC, Training Device Needs Statement (TDNS), a Commercial Training Device Requirement (CTDR), or a Training Device Requirement (TDR).

The Project Manager or AMC commodity command is responsible for the development, funding and procurement of system training devices. PM TRADE has the mission to prepare CFPs for all AMC system devices. Also, PM TRADE is frequently requested to serve a system PM as developer of system specific training devices. For most non-system training devices, PM TRADE is responsible for development, funding and procurement.

The development of training devices, both system and non-system, essentially follows the same life cycle system acquisition model as weapon systems. The need for a training device must be identified as the training concept is identified. The device itself will parallel equipment development and should be ready for IOT&E.

Training devices, such as items of hardware/software, at times may be more complex than the weapon system itself. During the development of training devices, each MANPRINT domain is considered. Some of the questions to be addressed in each domain include:

- Manpower - How many people will be required to operate, maintain and support the device? Who will operate, maintain and support the device? (Military, DA civilian, contractor.)

- Personnel - What special skills are required to operate, maintain and support the device? (MOS, ASI, specialty in civilian life.) A corollary question is: "How many personnel will it take to keep the requirements filled?"

- Training - How will individuals or crews be trained? What job aids are required? What technical manuals? Will knowledge be transferred effectively?

- Health Hazard - Does the device involve: Laser? Noise? Vibration? Fumes? Will its use cause: Motion sickness? Psychological issues? Stress? Isolation?

- System Safety - Have considerations of back blast, misfires, practice ammunition, etc., been addressed?

- Human Factors Engineering - Can soldiers train on the devices for long periods of time? Can instructors operate instructor stations with ease?

5. Human Factors Engineering (HFE)

It is important to relieve any definitional confusion between HFE and MANPRINT, because it is obvious that some of the MANPRINT domains are shown in the HFE definitions. First, it should be recognized that HFE was institutionalized as a program long before the advent of MANPRINT. In a real sense, then, HFE has always attempted to address some issues now encompassed by MANPRINT. The MANPRINT program gives a new emphasis to the human resources and human capability areas as related to system performance. MANPRINT relies strongly on the HFE program. In fact, in contracting for system concepts or system development, MANPRINT may employ MIL-H-46855B as the basic document to implement the MANPRINT program. One of the distinctions between MANPRINT and HFE, as currently defined, is that MANPRINT is specifically oriented to integrate all of the MANPRINT domains.

In its broadest sense, HFE is concerned with eliminating, through design, the typical sources of human error depicted in Figure G-9.

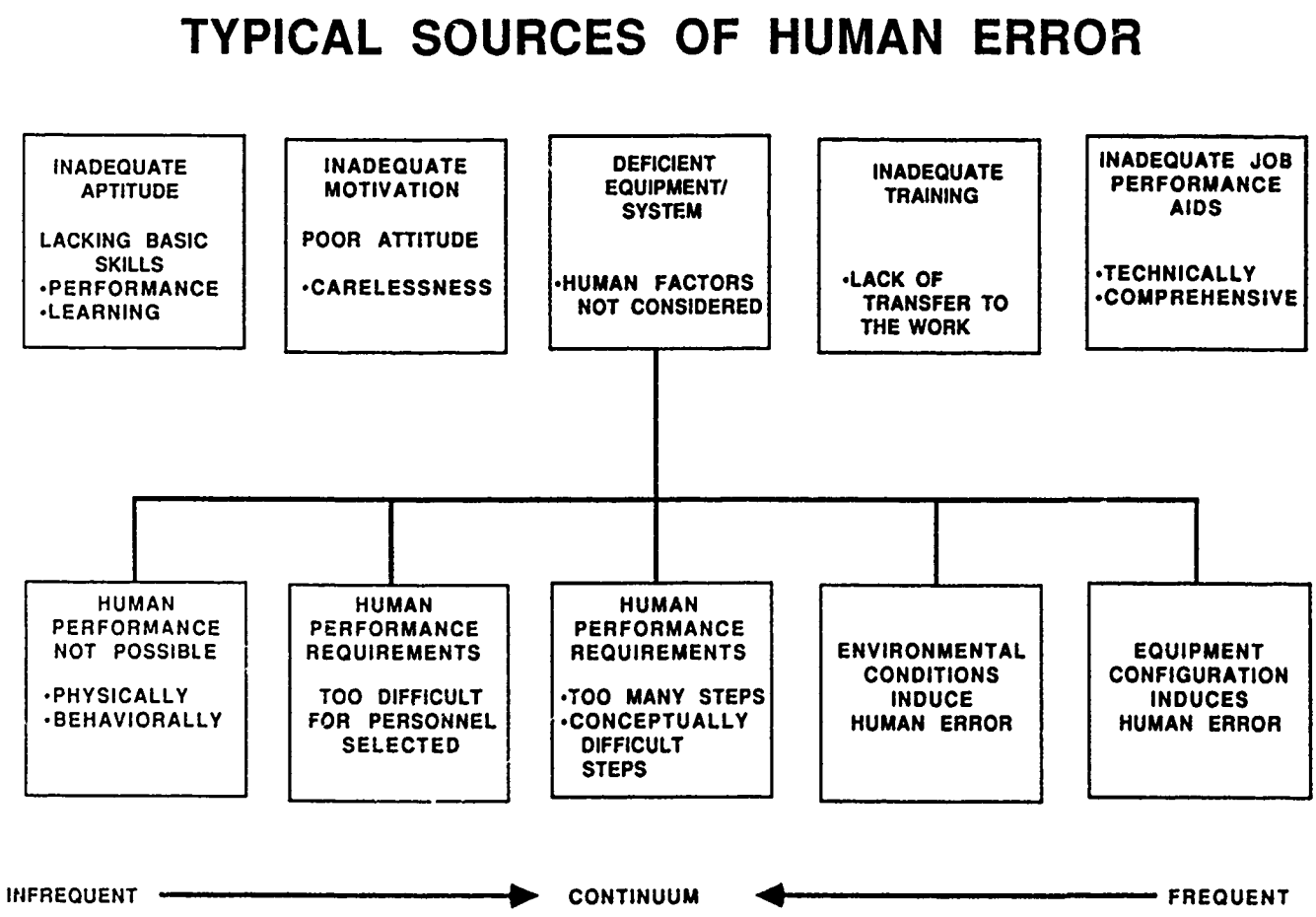


Figure G-9. Typical Sources of Human Error

HFE deals with the recognition that whether a system is manual, semi-automatic or automatic, the soldiers who operate or maintain it must be integrated functionally into that system. HFE recognizes that human reliability and human performance are integral parts of system reliability and system performance. The development process must adapt to the fact that human performance deteriorates with prolonged stress caused by lack of sleep, heat, noise, fatigue, isolation, overwork, etc. It must also adjust to such fundamental human reliability/performance influences as motivation, conflict, fear, etc. Figure G-10 shows the distinction between human performance and reliability.

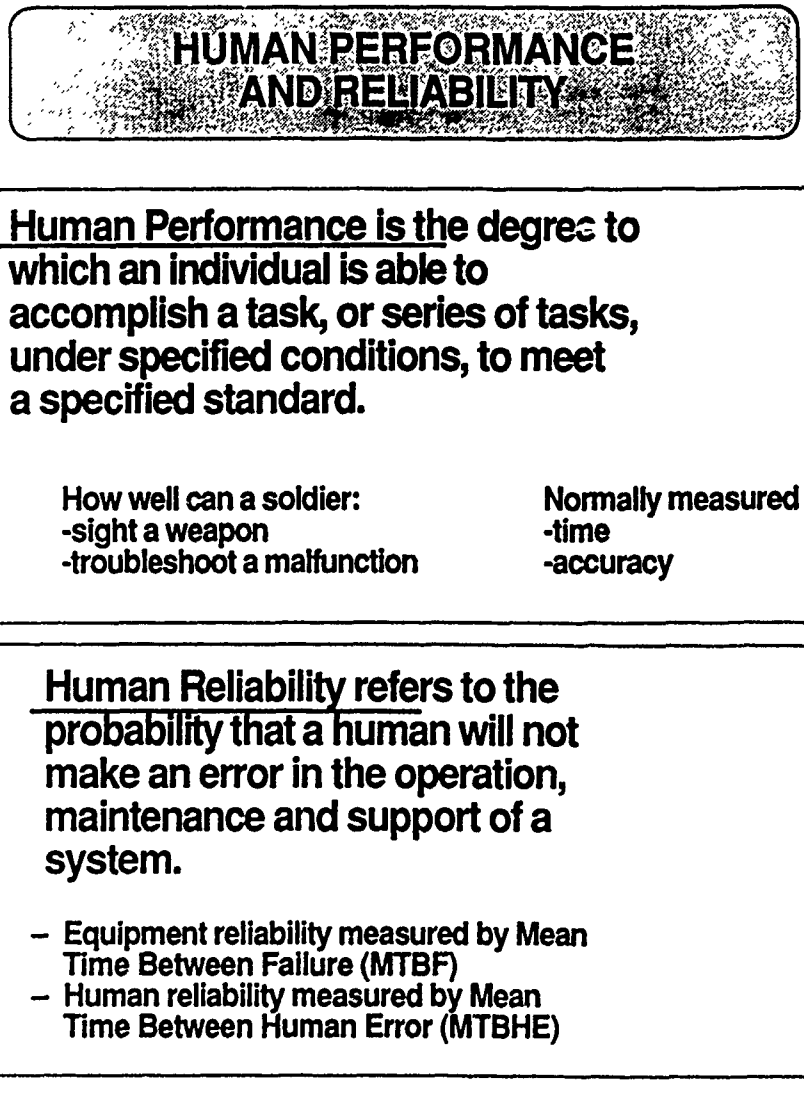


Figure G-10. Human Performance and Reliability

Design and sizing must ensure accommodation, compatibility, operability, and maintainability by at least 90 percent of the target audience. Generally, design limits should be based upon a range from the 5th to 95th percentile values for critical body dimensions. The critical anthropometric data should be identified in the Target Audience Description. An example of a critical dimension for a shoulder-fired missile weapon would be shoulder width. As the dimensions are sensitive to race, gender and age, knowledge of the target audience is critical. (For more information, see MIL-HDBK-759A.)

Human Factors Engineering is concerned with the design, development, testing, evaluation and deployment of manned systems so that soldiers will be able to operate and maintain military systems at their optimum performance levels. This includes the systematic investigation of how the design of the soldier's job and the tools that are provided affect his/her capacity to do the job. The major emphasis is on system reliability and performance, soldier-equipment compatibility, understanding of cost-benefits and ultimately, the achievement of user acceptance.

Without proper attention to HFE early in design, system flaws and deficiencies will surface that are difficult, costly and time consuming to deal with once the design is relatively frozen. Typically, some of these flaws and deficiencies include:

- System requires one soldier to do the work of two.
- System requires memorization of arbitrary codes and numbers that may not be remembered under battle stress conditions.
- System requires the operator to make himself/herself extremely vulnerable to enemy counter-fire.
- System requires major dismantling for access to frequently replaced components (i.e., minor repairs require major time).

Figure G-11 provides an outline of the process and trade-off for achieving man-machine optimization. Tradeoffs within the MANPRINT domains would address such issues as manpower distribution, force structure, quality distribution and training burden.

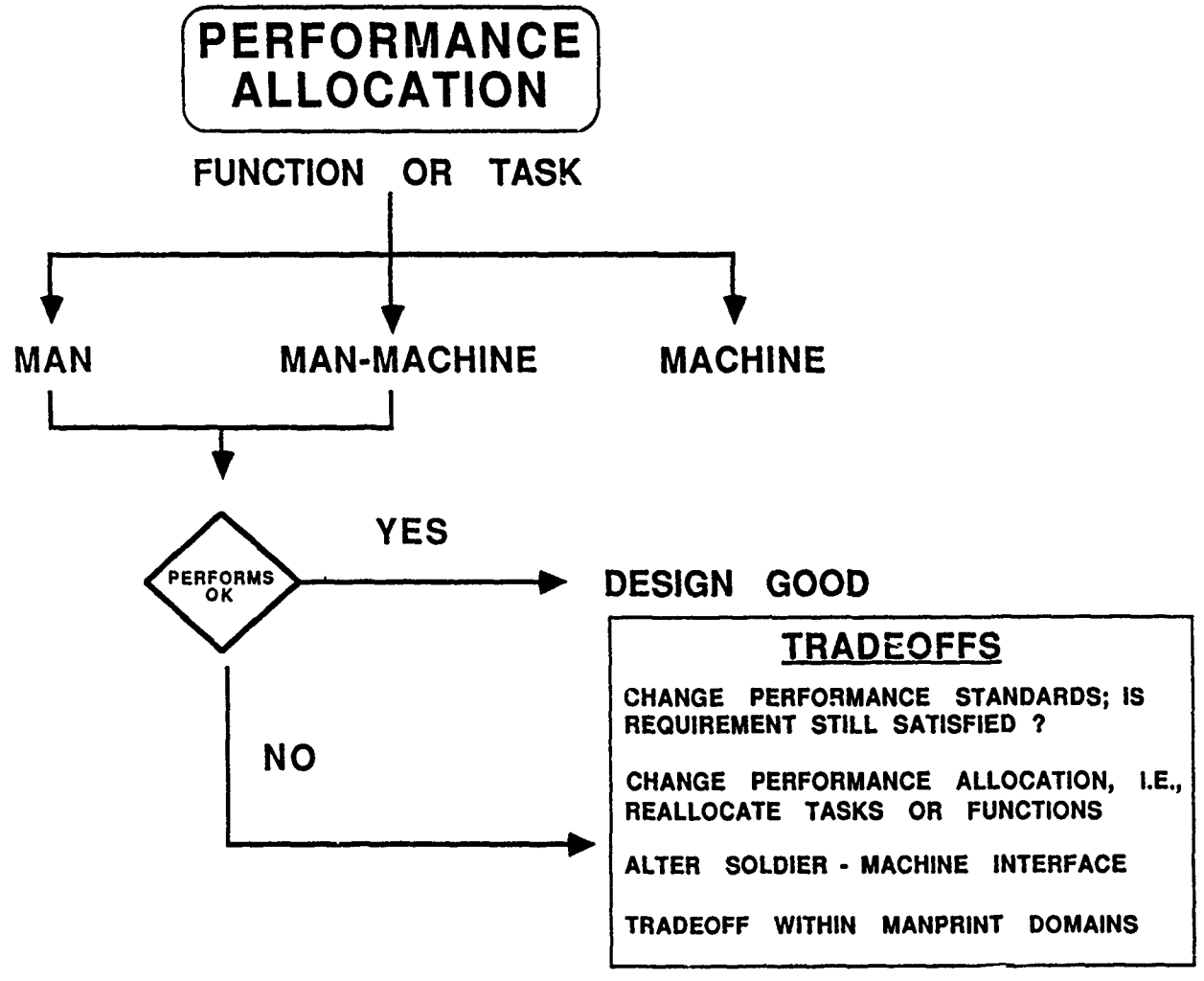


Figure G-11. Performance Allocation

5.1 HFE Methodology

The HFE methodology is similar to that used for other MANPRINT domains. In general, it consists of:

a. Determining the role of the soldier in carrying out the numerous system functions. Will he or she be an operator, maintainer, communicator, decision-maker, etc.?

b. Projecting the operational and environmental conditions under which the system is to operate. Through analysis of predecessor or reference systems, the potential role of the soldier is elucidated. The analysis seeks to address such questions as: "What human functions and soldier-machine functions have been successful and unsuccessful?" "Will the soldier be able to achieve the mission under all environmental conditions?" As

with MPT, the analysis leads to the establishment of goals and constraints for the design effort.

c. Conducting sensitivity and trade-off studies establishes the advantages and disadvantages of using soldiers in alternative roles. System functions are examined with respect to alternative soldier-machine allocations. The overall process provides insight as to the preferred allocation candidates. Of course, the trade-off criteria also include cost and development time.

d. During development, functions are broken down into tasks so that human engineering design requirements can be developed and incorporated into the system design. The task analyses include listing tasks/subtasks for each of such things as the stimulus-decision-response elements, the equipment employed, the skills required and the relationships to other tasks/subtasks. Variations of tasks analyses can be used to determine: information and control requirements, skill requirements, operational sequences, operator-equipment links and workload prediction. The effort is used to influence facets of the design such as station arrangements, workspace, console design, controls/displays, ingress/egress and maintenance.

e. Fine-tuning the development as it progresses assures that the human engineering issues are validated through the test and evaluation process.

f. During production and product improvement, assessing the impact of changes on operators and maintainers.

g. Assessing the Human Factors Engineering Program through the Human Factors Engineering Analysis (HFEA). The HFEA reflects the results of an assessment of each of the six MANPRINT domains to establish whether issues exist which would preclude the scheduled transition of an acquisition program to the next phase of the materiel acquisition life cycle. The HFEA also identifies concerns, which, while not critical in terms of program decisions, are resolvable and must be addressed during the next phase of the acquisition cycle. AMC's Human Engineering Laboratory is responsible for conducting the HFEA with input from TRADOC, the Office of The Surgeon General, AMC Safety Offices and others. Details of the HFEA process are described in HEL Memorandum 70-9. A chapter on the HFEA is planned to be included in the next revision of the AMC/TRADOC Pamphlet 70-2, Materiel Acquisition Handbook.

6. System Safety

The Army has the responsibility to ensure that hazards to the soldier are not system induced. As systems become more complex, and the battlefield reflects the doctrine of continuous and sustained operations, the soldier's exposure to system hazards increases. The System Safety program is designed to identify and measure safety hazards with the objective of:

- Maximizing operational readiness and mission performance through accident prevention
- Ensuring safety and health risks are eliminated and residual hazards are formally accepted and documented
- Minimizing safety retrofits
- Ensuring that equipment modifications and doctrinal changes do not lessen safety and health aspects of a system
- Applying system safety engineering and management principles to developing technology for new systems

The goal of system safety is to design equipment so that safety considerations do not adversely affect soldier performance or increase demands on manpower, personnel or training resources. No safety hazards will be accepted by the Army without formal documentation of associated risks. The hazard analysis process is reflected in Figure G-12.

SYSTEM SAFETY ENGINEERING

Figure G-12. System Safety Engineering

The materiel developer is responsible for conducting a tailored system safety program for all developed systems. Each PM office will establish a System Safety Working Group (SSWG) to track hazards and document corrective actions. Prior to each Milestone Decision Review, the SSWG will prepare a System Safety Risk Assessment that documents the materiel developer's position on these safety hazards that have not been eliminated by system design.

Industry conducts its own safety program that parallels that of the Army. MIL STD 882 details the tasks and activities that are to be performed by the contractor to identify, evaluate, and eliminate safety hazards of a system or to reduce their associated risks to a level acceptable to the Army. Prior to the start of operational or developmental testing, industry will produce a Safety Assessment Report that summarizes the hazard potential of a system and recommends procedures to reduce risks to test personnel to an acceptable level.

System safety has an impact on the other domains. For example, the System Safety Risk Assessment will be used in preparing the HFEA (AR 602-1). Additionally, training programs may be required for those safety hazards that have been accepted by the Army as a result of constraints imposed by operational effectiveness, time or cost.

7. Health Hazards

Advanced technologies and sophisticated, complex systems have brought with them greater potential of harm due to greater noise, overpressure, shock and vibration, higher levels of toxic fumes, gases and chemicals, and a myriad of other conditions. These increases in the degree and intensity of hazardous conditions provide major reasons for concern. The health hazards arising from new technologies, such as lasers and ionizing and non-ionizing radiation, gives reason for even greater concern. The Health Hazard Assessment program meshes with the System Safety program in an effort to:

- Preserve and protect the health of the individual soldier and other personnel.

- Enhance soldier performance and system effectiveness.

- Reduce requirements for system design retrofits needed to eliminate or control health hazards.

- Reduce readiness deficiencies attributable to health hazards that bring about restrictions in training or operational restrictions.

- Reduce personnel compensation by eliminating or reducing injuries attributable to health hazards associated with the use of Army systems.

The basic goal of HHA is to identify health hazards as early as possible for elimination and/or control. It is desired that the optimum degree of health features be integrated into a system design within the bounds of cost, operational effectiveness and time. As expressed in AR 40-10, there will be no compromise of health protection criteria and standards without formal documentation of the accepted risks.

The mental as well as physical hazards must be considered in order to minimize potential psychiatric casualties. These casualties can result from a lack of confidence in equipment, organizational or doctrinal isolation, and a nonsupportive social environment. For example, in World War II the French employed their tanks individually rather than in mass (doctrinal isolation). Inside the tank, the crew was physically isolated (crew social isolation). This had a negative impact on the effectiveness and sustainability of French tank crews. Training is often the solution to these types of casualties, resulting in a greater training burden.

The assessment of health hazards must be conducted by competent Army Medical Department (AMEDD) professionals to determine the overall impact. HHA are not automatically triggered by some activity or event in the materiel acquisition process. These assessments are initiated only upon formal request through the Surgeon General's Office (TSG). The formal Health Hazard Assessment Reports (HHAR) usually become part of the Human Factors Engineering Analysis (HFEA) which covers all of the MANPRINT domains. The HHA is updated based on new or more mature data prior to each Milestone review.

HHA procedures are integrated throughout the materiel acquisition process. In the design process, health hazard analyses are conducted to evaluate hazard severity and probability, to assess risk and to determine operational constraints. This effort also identifies required precautions, protective devices and training requirements to minimize potential hazards. Later in the materiel acquisition life cycle, the HHA is used to assess contractor performance and to insure that health hazard recommendations are incorporated in doctrinal, maintenance and training publications. Figure G-13 reflects the general process for influencing the design process.

HOW?

Process Model at the Level of Specific Design Decision Making

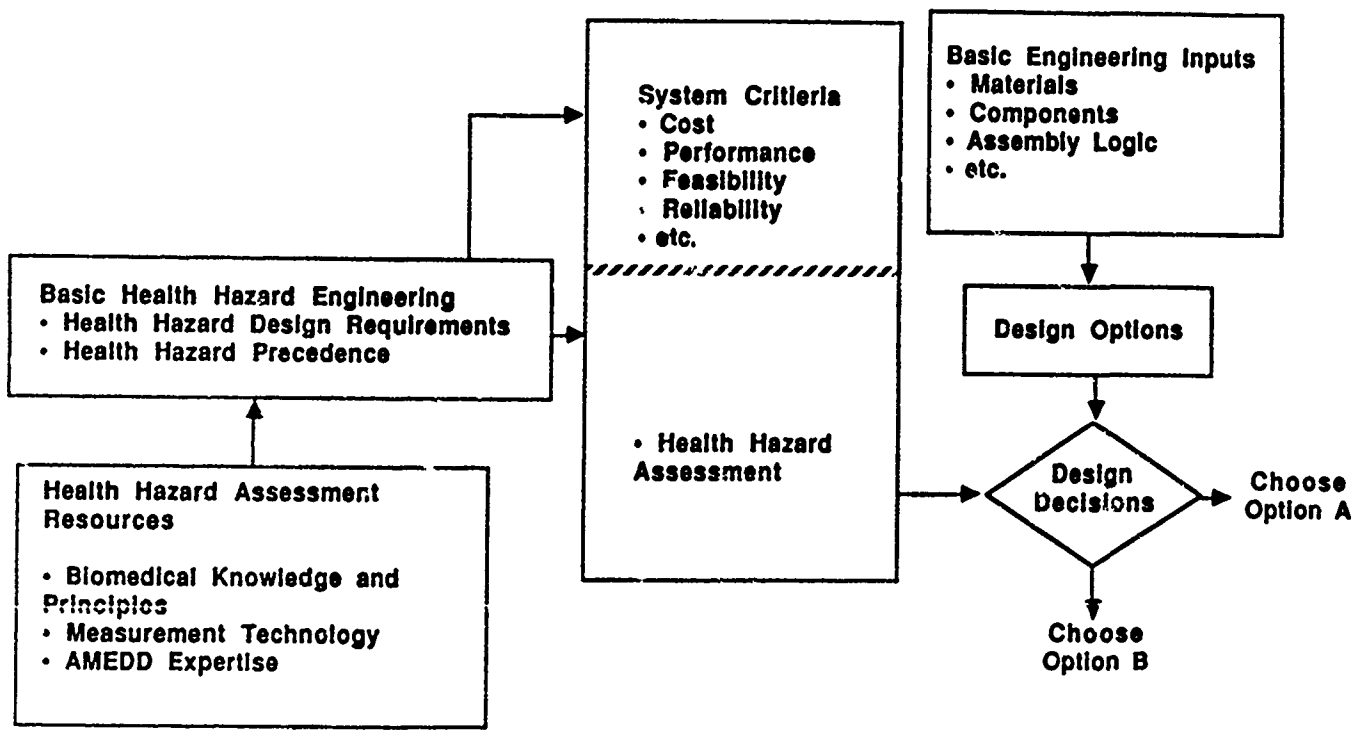


Figure G-13. Health Hazards "How?"

Industry has the responsibility to design a system that eliminates or controls soldier and crew exposure to hazards. MIL STD 882 provides a means for the Army to request contractor supplied data that details those efforts taken to identify hazards of a system and to impose design requirements and management controls. The task descriptions should be selectively tailored based on system complexity, technology and program cost.

The Health Hazard domain interfaces directly with the other domains. For example, if a particular health hazard cannot be eliminated through re-design, it may be necessary to reduce the risk by specialized training or by limiting personnel selected to operate and maintain the equipment. This is particularly important in the area of Nondevelopmental Items (NDI) where the equipment design is fixed prior to the time of a procurement decision. Finally, as with system safety, the Health Hazard Assessment Report will be used in preparing the HFEA.